Electrical World and Engineer

THE CONSOLIDATION OF "THE ELECTRICAL WORLD" AND "ELECTRICAL ENGINEER."

VOL. XLI. NEW YORK, SATURDAY, APRIL 25, 1903. No. 17.

ELECTRICAL WORLD AND ENGINEER

Published weekly by the

McGRAW PUBLISHING CO.

114 LIBERTY STREET, NEW YORK.

TELEPHONE CALL: 7605 CORTLANDT. CABLE ADDRESS: ELECTRICAL, NEW YORK.

EDITED BY T. C. MARTIN AND W. D. WEAVER.

CHICAGO OFFICE - - - - - - 1139 Monadnock Block.
PHILADELPHIA OFFICE - - - - - - 929 Chestnut Street.
EUROPEAN OFFICE Hastings House,, Norfolk St., Strand, London, England.

NOTICE TO READERS
WHO ARE NOT SUBSCRIBERS.

The ELECTRICAL WORLD AND ENGINEER is not returnable from the newsdealer. If you desire to purchase the paper from a dealer it will be to your advantage to notify him that you will want it, in order to insure his having a copy for you. If you wish to receive the paper regularly, please send in your subscription so that we can mail it to you direct.

Single copies are 10 cents each. The 52 copies for the entire year cost $3.00 in advance. Please send remittance with your subscription order.

ELECTRICAL WORLD AND ENGINEER.

NOTICE TO ADVERTISERS.

Change in advertisements intended for a particular issue should reach the office of the ELECTRICAL WORLD AND ENGINEER by 10 A. M. MONDAY of the week of issue. New advertisements can be received up to noon of Tuesday of the week of issue.

The first issue of each month is an export issue, having an extraordinarily large foreign circulation in addition to the regular domestic and foreign circulation of this paper.

TERMS OF SUBSCRIPTION.

United States, Canada or Mexico - - - - - -	per year, $3.00
Foreign Countries, within the Postal Union - - - - -	6.00
Great Britain and Ireland - - - - - - - - - -	25 shillings
Germany - - - - - - - - - - - -	25 marks
France - - - - - - - - - - - - -	31 francs
Single copies - - - - - - - - - - - - -	.10

Remittances for foreign subscriptions may be made through our European office.
In requesting your address changed give OLD as well as new address.

Copyright, 1902, by McGRAW PUBLISHING CO.

Entered as second-class mail matter at the New York Post Office.

NEW YORK, SATURDAY, APRIL 25, 1903.

CONTENTS.

Editorial	681
The John Fritz Medal	684
A. I. E. E. Philadelphia Meeting	684
Magnetic Club Dinner to Col. Clowry	684
Telephone Exchanges—I. By Arthur V. Abbott, C. E.	685
Telephone Development in the Philippines	688
Telephone Service in New York Hotels	689
Corrosion by Electrolysis	690
Meeting of the Chicago Electrical Association on Overhead Distribution	691
New Telephone Patents	692
An Electric Moving Platform Between New York and Brooklyn	692
The Daft and Williams' System of Electrical Prospecting for Mineral Ores	693
General Meeting of the American Electrochemical Society	694
Lecture of Mr. W. J. Hammer	698
Current News and Notes	699
Digest of Current Electrical Literature	701
Cascade Water, Power & Light Co., Cascade, B. C., Canada. By W. G. McConnon	705
Development in Telephone Switchboard Equipment at Bloomington, Ill.	706
Alternating Current Long Scale Voltmeter and Ammeter	708
Power Transmission in Connecticut	708
Core Type Transformers	709
Automatic Motor Starter	710
Tap and Reamer	710
Financial Intelligence	711
Commercial Intelligence	712
General Specifications for the Construction of Telephone Aerial Lines	713
News of the Week	731

MEETING OF THE AMERICAN ELECTROCHEMICAL SOCIETY.

The meeting in New York last week of the American Electrochemical Society scored another success for this vigorous young body, not only with respect to the proceedings proper, but also through the admirable manner in which the social and other features added to the programme for this meeting were carried out. Credit for the latter is largely due to the local committee, which, under the enthusiastic leadership of Dr. Doremus and Mr. Von Isakovics, made a record that will tax to the utmost those in charge of local arrangements for future meetings to maintain. The banquet on Thursday evening, at which Dr. Nernst was guest of honor, and the lectures by Mr. Hammer and Dr. Recklinghausen on the two following evenings, were fitting daily finales to morning programmes of papers and afternoon excursions. The holding of a joint evening meeting with the American Institute of Electrical Engineers doubtless recalled to many with regret the failure of the effort to make definite arrangements for joint annual general meetings of two bodies so closely allied in their objects and overlapping so considerably in membership.

The lecture by Mr. Hammer was highly interesting from the great amount of new information it conveyed relating to most timely subjects, combined with numerous and brilliant illustrative experiments. In the course of his lecture Mr. Hammer brought out the fact that certain experiments of a German savant which have been widely published and which contradicted the accepted view that radium does not lose appreciable weight while giving forth radiant energy, were based upon experiments involving errors that invalidated the contradictory conclusions put forth. Mr. Hammer also made the important announcement that he had succeeded in reversing the Röntgen ray cycle, producing within a Crookes tube a cathode stream by bombarding the exterior with Röntgen rays, a process which he demonstrated experimentally before the audience.

Of the score or more papers read before the society, a considerable portion were of an academic character, and few of these having been printed in advance, discussion was either lacking or aimless in character. Those that dealt with controversial points, or related to experiments giving results apparently at variance with, or calling for extensions of, accepted theory, might with greater profit have been contributed to periodical publications, thereby attracting to subsequent issues the comment and criticism to which new or radical views should be subjected. Should papers of this class continue to be accepted without an explicit proviso that they shall be in type some days in advance of a meeting, members well qualified in the branch to which the subjects relate should be solicited to contribute communications to be printed with the papers in the *Transactions*. Otherwise the printed proceedings of the society will continue to be sprinkled with conundrums and "catch questions," with the answer aggravatingly absent.

About half of the papers read were on practical subjects, notably a paper by Profs. Burgess and Hambüchen, on the electrolytic production of metallic compounds, and one by Mr. Titus Ulke on modern electrolytic copper refining. Dr. Recklinghausen in a paper directed the attention of electrochemists to the subject of insulating materials, discussing the properties of those now in use and pointing out the direction in which improvements may be made. Different aspects of electrodeposition were treated by Messrs. Zimmerman, Keith, Johnson and Mailloux, the latter referring to some experiments he made which showed the practicability of a current density

as high as 500 amperes per square foot. Mr. Carl Hering set forth the desirability of uniformity with respect to electrochemcial equivalents, and while not denying this, Prof. Bancroft pointed out the difficulty in the way due to conflicting values. Prof. Bancroft in a paper gave a useful classification of metals with respect to hydrogen, on the basis of the order in which deposition of the latter begins at different metals in aqueous solutions. Finally, mention should not be omitted of the generous gift by Mr. A. B. Freznel of a prize of $250 to the best paper read before the society on the subject of the practical treatment of certain rare metals. Mr. Freznel stated that great deposits of such metals exist in Arizona and neighboring sections, and the development of the fields only await the discovery of practical processes for the working of the minerals, which processes are most apt to come within the scope of research of the electrochemist.

ELECTROLYTIC CONDUCTION WITHOUT ELECTRODES.

A paper of this title was read by Mr. A. B. Marvin at the meeting of the American Electrochemical Society last week. There is still much doubt in the minds of electricians as to the behavior of electrolytes in a circuit devoid of any extraneous electromotive force. It is universally admitted that an electrolyte will offer a conducting path to a current generated by an external electric source, such as a dynamo. But when the question is asked as to what happens in case the circuit were wholly electrolytic, and the conductors on the dynamo were glass tubes containing electrolytes, the answer is not so universally rendered. If the electronic theory be admitted, and if it is taken for granted that electricity is conducted wholly by the motion of electrons, either step-by-step between neighboring virtually stationary molecules in metallic wires, or by porterage on the back of moving ions in liquids, then there is no essential difference between the two classes of conductors, and a circuit composed wholly of an electrolyte —that is, a liquid circuit—should conduct to all intents and purposes exactly like a circuit composed wholly of copper wire, except in so far as the difference in conductivity might influence the strength of the current. Some experiments have been conducted and described by J. J. Thomson on the comparative conduction of electrodeless electrolytic tubes, and of electrodeless partial vacuum tubes. These experiments seem to show that both electrolytes and gases possess a definite conductivity, in the absence of electrodes. Moreover, it would appear that the best conductivity of electrodeless electrolytes is of the same order of magnitude as the conductivity of electrodeless gases, and both are extremely small by comparison with the conductivity of such metals as silver and copper.

The paper of Mr. Marvin describes certain experiments conducted with the view of putting the conductance of purely electrolytic circuits to the proof. A little unipolar dynamo was constructed, in which the rotating armature conductors were of electrolyte. There were difficulties in making this dynamo deliver a decided e.m.f., owing to centrifugal forces. The detecting galvanometer consisted of a solenoid of glass tube filled with electrolyte. The low speed of available rotation of the electrolyte dynamo armature, and the high resistance of the electrolyte circuit prevented satisfactory indications from being directly obtained. Successful results were, however, obtained by employing an alternating-current transformer with an ordinary copper wire primary winding and a single-turn secondary winding, consisting of an insulating trough filled with electrolyte. This was carried out to a small induction-coil at some distance, through electrolyte tubes, the primary winding of the induction coil being also an electrolyte tube. The secondary winding of the induction coil was of copper wire insulated in the ordinary way, and connected to a telephone. Opening and closing the electrolyte circuit, by the insertion and withdrawal of rubber stoppers in the tubes leading from the trough, was accompanied by clear indications of the cessation and passage of alternating current in the telephone.

While the experiment, if accurately performed and described, seems conclusive as to the passage of currents in wholly electrolytic circuits, yet any other result and conclusion would appear extraordinary. There can be no doubt, from experimental observation, that a moving magnetic field develops an e.m.f. in any region, whether the region contain an insulator or a conductor, and whether the contents of the region are solid, liquid, or gaseous. Consequently, when a moving magnetic field cuts a column of electrolyte contained in a glass tube, the column is subjected to electromotive force and electrostatic stress, in a manner which, at any point not in the immediate vicinity of the ends, must be equivalent to that produced by connecting the liquid column with electrodes connected to a corresponding electric difference of potential. Consequently, it is only reasonable to expect that if conduction took place through the mass of the column in the one case, it would do so through the other. Nevertheless, the experimental demonstration is well worth having.

VERY BRIEF ELECTRICAL CONTACTS.

The last number of *The Physical Review* contains an abstract of a paper read by Mr. H. C. Parker at the December meeting of the Physical Society, on some experiments concerning very brief electrical contacts. The principle of these experiments is comparatively old, similar experiments having been reported by R. Sabine about twenty years ago; but the details of the experiments here described have especial interest. A gravity key was arranged so as to provide means for making contacts of duration varying between one-tenth of a second, and ten micro-seconds. A condenser was charged through the contact in circuit with a known resistance. The charge which accumulates in the condenser under such circumstances varies with the resistance and the time of contact. By comparing the charge with that obtained from the same e.m.f. in a steady prolonged charge, the time of contact is deducible.

Similar experiments are described using a steel ball suspended by a wire, and allowed to impinge upon a steel anvil. The period of contact between the ball and anvil is known to be exceedingly brief. It varies with the size of the ball, the modulus of elasticity of the metals, and the velocity of impact. In the experiments described, it varied between 79 and 390 microseconds. The period of contact between a steel hammer falling upon a steel anvil is of the same order of magnitude. It is possible to make short-circuits through the brief contact between an anvil and a rebounding hammer, which will give rise to but little rush of current when an appreciable amount of inductance is included in the circuit. For example, a small fuse in the circuit of such a hammer-and-anvil short-circuit can be arranged to withstand the application of a considerable e.m.f. without being melted, owing to the brief duration of the short-circuit and the repressing influence of a choking coil in the path.

RESONANCE IN ELECTRIC CIRCUITS.

The oscillograph is a most useful piece of apparatus in the hands of the electrical engineer and of the electrical investigator. It has proved of great industrial value in particular cases of troubles in electric circuits, where very sudden rises of pressure or current were apt to take place from unknown causes, and where oscillograms gave information as definite to the electrical engineer, as an indicator diagram may give to a steam engineer—in fact, more so since they record continuously instantaneous values. The Duddell oscillograph has been employed by Mr. M. B. Field to investigate some relatively feeble

resonance phenomena observed in the Glasgow central station, and described in a recent paper before the British Institution of Electrical Engineers. A number of oscillograms taken under practical conditions appear in the paper. The three-phase generators supplying the system are of 2,500-kw capacity, and supply alternating currents at a normal pressure of 6,500 volts and 25 cycles per second. The waves of e.m.f. were substantially sinusoidal with a ripple of twelve times the frequency, and of appreciable amplitude, superposed. This harmonic was due to the armature teeth, there being 12 teeth per wave in the armature winding. This represented a superposed frequency of 300 cycles per second, although a closer analysis of the wave form indicated that the disturbance was more nearly a combination of the odd harmonics, eleventh and thirteenth, rather than of the even twelfth harmonic.

By appropriate connections and instruments these harmonics could be detected not only in the alternating currents supplied to the high-pressure distributing system, but also in the direct currents fed by the converters operating on, and driven by, the system. By driving one converter independently as a generator, as well as a second one from the alternating-current system, and bringing their direct-current terminals into opposition through an alternating-current voltmeter and direct-current voltmeter in parallel, the former indicated 12 volts when the latter indicated zero. That is to say, when the rippling direct-current pressure of the converter was adjusted into equality and opposition with a direct-current pressure of some 500 volts generated by a dynamo, the direct-current voltmeter between them was brought to zero, since the ripples would not indicate; whereas the alternating current voltmeter would measure the ripples and indicate their effective values. None of the experiments described showed any very marked resonance in the system due to the 300-cycle frequency, but many of the results obtained are both interesting and instructive.

Electrolytic Corrosion.

We have heard so much of electrolysis in the last few years that the subject of Mr. Knudson's paper was not particularly appealing, but on inspection it has proved to be somewhat out of the ordinary. The usual course of an electrolysis story is alleged to be about as follows: New city administration comes in and boss of water works finds it necessary to do some extra digging; finds pipes rusty and writes to the newspapers, also to the trolley company that didn't come down with the stuff during the campaign; boss gets letter from expert looking for a job; mayor and boss get him to help soak the trolley company; expert with many instruments arrives and finds volts thicker than Croton bugs in a Harlem flat; suit started against trolley company with injunctions on the side; smooth gentleman with patent bonds and things blows around to see the trolley company; trolley company's attorney sees mayor and presents smooth gentleman; long fight before facetious aldermen on the subject; expert endorses smooth gentleman's plan for avoiding further trouble; road closes contract; sees treasurer of campaign club; smooth gentleman and expert retire to corner and divide; everybody happy except the trolley company. We are far from disbelieving in electrolysis or holding remedies up to scorn, yet we feel that there is much misunderstanding on the subject, which Mr. Knudson's paper will materially help to clear up. We particularly note the excellent examples he gives of cases of dangerous corrosion in which no stray current was involved, but which arose from the presence in an electrolyte of dissimilar contiguous metals. This is a subject which deserves a thorough investigation experimentally, and we have no doubt that plenty of trouble will be found which does not arise from wandering trolley currents.

As a matter of experience it is rather difficult to find two samples of metal which will not show electrolytic effects under favorable circumstances. For instance, it has been found extremely difficult to avoid severe corrosion in the cases for submarine mines even when very nearly identical material is used throughout. Local action freely occurs even between steel bolts and sheet steel in such cases, and we have no doubt that an ordinary water pipe and a steel rail side by side in the moist earth of a city street will display electrolytic action quite irrespective of earth currents. On the other hand, even in localities admittedly dangerous electrolysis may produce very little real damage owing to the character of the soil. Given the specimens and the circumstances and it is often very easy to tell definitely the existence and cause of damage; but it is very difficult to predict either the conditions or the probable damage, to say nothing of the effect likely to be produced by proper remedies. Broadly, the better the rail return in a tramway system the less likely is severe electrolytic action, and in so far improving that return is a good thing, as from every other point of view, but Mr. Knudson is probably right in saying that any kind of rail return is liable to make trouble. There is no dodging Ohm's law, and rails laid with moist earth and water pipes beneath them will infallibly share their current with their neighbors. Moist earth has low specific conductivity, but a long stretch of it between a 90-lb. rail and a 2-ft. water main is in the aggregate a pretty good conductor, and once in the main the current will somewhere leave it with the usual parting kick. The real practical damage depends chiefly on the amount of concentration in the action. General corrosion may go on for years without causing serious trouble, while if localized it may ruin a pipe in a few weeks or months.

In and about New York the question of bridges becomes serious in its tendency to localize electrolysis. While it seems probable that no serious effect is to be expected on the bridges themselves, if reasonable care is exercised, the concentration of stray current is very marked and may be the source of considerable trouble. A careful watch with frequent tests should be kept for such effects, and a few years will locate the dangerous areas and enable local remedies to be applied. It is hard to say what is the probable value of local treatment, but it certainly has some importance and should be employed wherever there seems to be prospect of good results. One of the topics which Mr. Knudson might have taken up with advantage is the possible effect of electrolysis in steel buildings. In these days steel is used in enormous amounts underground as well as above ground in such structures, and we have as yet very little knowledge as to whether electrolysis is at work or not. Both lighting and railway currents may conceivably be at work in such cases, and it is some importance to find out the results. Even a small current steadily at work for a few years may do a great deal of mischief before it is discovered. Damage to buildings is particularly difficult to detect on account of its situation, and while it may be practically of very little moment it is well worth looking for. Possibly during the rebuilding of some of the earlier steel structures which is likely to occur as ground space gains in value, some very useful information may be gained. Where, as sometimes happens in exposed spots, returning railway currents rise to considerable magnitude, local damage may be severe at points least expected, for no man can say just where the wandering currents flow. Electric currents can hardly be forbade the earth at present, but they will bear constant watching. In any event, constant alertness is required in dealing with the electrolysis problem, and electrical surveys properly conducted are necessary to a proper control of the conditions. The difference of potential method used alone is, however, open to grave objection, and in cases is likely to lead to erroneous conclusions, as pointed out in the discussion of Mr. Knudson's paper.

The John Fritz Medal.

At Albany, N. Y., on April 18 articles of incorporation of the John Fritz Medal Fund Corporation were filed with the Secretary of State. It is formed to collect and hold funds for a permanent investment, the proceeds of which will be used in the purchase of the gold medal to be known as the John Fritz medal, to be awarded annually to the person who shall be selected as having made the most notable scientific or industrial achievement during the period since the last award.

The medal is named to perpetuate the memory of John Fritz, of Bethlehem, Pa., and the Board of Award is made up of members of the Americain Society of Civil Engineers, the American Institute of Mining Engineers, the American Society of Mechanical Engineers and the American Institute of Electrical Engineers. The directors of the corporation are J. J. R. Croes, Alfred Noble, C. W. Hunt, E. E. Olcott, E. G. Spilsbury, James Douglas and C. Kirchhoff, of New York City; Robert Moore, of St. Louis; Gaetano Lanza, of Boston; John E. Sweet, of Syracuse; Robert W. Hunt, of Chicago; S. T. Wellman, of Cleveland; Arthur E. Kennelly, of Cambridge, Mass.; Carl Hering, of Philadelphia; Charles P. Steinmetz, of Schenectady, and Charles F. Scott, of Pittsburg.

The establishment of the medal was signalized last year by a banquet to celebrate the eightieth birthday of Mr. Fritz, and the fund contributed by about 480 subscribers represents a balance of about $4,000, the proceeds of which will be ample to provide the medal, the dies and designs of which are already familiar to the technical public.

A. I. E. E. Philadelphia Meeting.

The second meeting of the Philadelphia Branch of the American Institute of Electrical Engineers was held Monday, April 6, at the Engineers' Club of Philadelphia.

Mr. Carl Hering, the chairman, made a short opening address, and, after necessary business was transacted, Mr. Hewitt presented Mr. F. O. Blackwell's paper on the "Testing of Insulators" and Mr. Ralph D. Mershon's paper on "Mechanical Specifications for a Proposed Standard Insulator Pin." Mr. P. M. Lincoln, of Pittsburg, presented and discussed a paper by himself on "Transposition and Relative Location of Power and Telephone Wires.

Mr. H. H. Barnes, of Pittsfield, Mass., presented a paper on the "Burning of Wooden Pins on High-Tension Transmission Lines," read in New York by Mr. C. C. Chesney.

Mr. W. L. Hodges, the chief engineer of the Keystone Telephone Company, gave a brief résumé of the New York discussion of Mr. Lincoln's paper. Mr. Hodges disagreed with Mr. Gerry's statement that the ordinary telephone lightning arrester was an undesirable and unsafe piece of apparatus for properly taking care of telephone circuits. Mr. Hodges stated that he had had considerable experience with different types of arresters and found some that answered admirably. He stated that it must not be expected that an *ordinary* lightning arrester should be sufficient in *extraordinary* cases.

Mr. Hodges discussed the various difficulties liable to arise where telephone and high-tension circuits are run on the same poles, and came to the general conclusions that, in order to get the best transmission and safety combined,

First: Both power and telephone lines should be properly transposed. And this transposing is not altogether as simple a matter as it is generally supposed, as it would be possible to arrange the transpositioning so that the power and telephone wires would neutralize each other.

Second: The insulation of the telephone lines should be high, and, of course, the line should be strongly constructed.

Third: At each telephone station, the instrument circuit should be connected to the secondary of a transformer.

This transformer should have a high-resistance primary with a great number of turns, and the insulation between the primary and secondary should be high.

The middle point of the primary should be connected to ground through a retardation or choke coil. In each side of the telephone line circuit, at each station, there should be a so-called "lightning gap" arranged; designed so as to discharge when the potential of the telephone wires should approximate that which would break down the insulation of the line.

In the connection to ground of this lightning arrester, there should be placed an electromagnet of low resistance and low retardation; so arranged that by its operation it will open the telephone line between the arrester and transformer, and connect the ground side of the lightning arrester with the ground direct.

This method of construction, it will be seen, removes the objection that a workman would come in close proximity with the ground, while working on the telephone circuit. And also it provides necessary protection for the telephone user without allowing a path for leakage of the telephone current, or affecting the transmission by increase of capacity.

Mr. H. F. Sanville then gave an abstract of the New York discussions of the papers of Messrs. Blackwell, Mershon and Chesney.

A general discussion followed, during which a spirited controversy between Messrs. Lincoln and Hodges was carried on, regarding the electrostatic effect through a telephone receiver, due to the electrostatic effects of the main transmission line, Mr. Lincoln maintaining this is a constant current effect, and Mr. Hodges taking the stand that it is a constant potential effect.

Mr. Barnes, of Pittsfield; Mr. Theodore Spencer, Mr. Washington Devereux, Mr. C. B. Fulton, Mr. J. Silliman, Mr. R. L. Binder, Mr. Charles Hewitt, Mr. Hutchins and Mr. Carl Hering took part in the general discussion.

Magnetic Club Dinner to Col. Clowry.

The annual dinner of the Magnetic Club was given at the Hotel Vendome, Forty-first Street and Broadway, New York, on the evening of April 18, and was one of the most successful ever held by the club both in point of attendance and enthusiasm. Col. R. C. Clowry, president of the Western Union Telegraph Company, was the club's guest, and 250 members and their friends assembled to do him honor. The dinner was served in the large dining hall on the ninth floor of the hotel. Between the courses vocal and instrumental music was rendered by various artists, which kept the enthusiasm up to the highest pitch all through the evening. On the wall back of the president's table, at which all of the invited guests were seated, was the club's insignia—a horseshoe magnet with "73" between the two poles, in electric lamps; and at the other end of the room was hung on the wall the club's motto, in large letters, "Are You Happy?" On each table stood a miniature telegraph pole complete in its fittings.

At the conclusion of the dinner President F. W. Jones, in a few well-chosen remarks, introduced the guest of the evening, who was greeted with hearty applause, followed by the singing of "The Star-Spangled Banner," by the entire company.

Col. Clowry responded to the ovation in a brief address, in which he reviewed some of his early experiences as a telegraph operator. He expressed the belief that there is no better business training for a young man than telegraphy, and the careers of many leading business men of New York confirmed the opinion. Fully 85 per cent. of the railway managers of the United States, he said, were telegraph operators in their younger days, and he constantly met with men of prominence in every branch of business who served an apprenticeship at the key.

Remarks were also made by Col. A. B. Chandler, chairman of the board of directors of the Postal Telegraph Company; W. H. Baker, vice-president of the same company; H. D. Estabrook, solicitor for the Western Union Telegraph Company, and F. W. Jones, president of the club.

Letters of regret at their inability to be present at the dinner were read from Mr. Thomas A. Edison, Mr. Andrew Carnegie and other prominent gentlemen. A feature of the dinner was the serving of the punch in glass insulators, and each person received as a souvenir of the occasion a miniature glass insulator to be worn suspended from a button hole by means of a short length of magnet wire.

Among those present, in addition to those above mentioned, were J. C. Barclay, assistant general manager of the Western Union Telegraph Company; D. H. Bates, an old-time telegraph official, but now a bank official; B. Brooks, general superintendent of the Western Union Company; G. G. Ward, vice-president and general manager of the Commercial Cable Company; E. C. Platt, treasurer of the Postal Telegraph Company; H. L. Shippy, treasurer The John A. Roebling's Son's Company; E. G. Willyoung and many others well known in the various branches of electrical industry.

Telephone Exchanges.—I.

BY ARTHUR V. ABBOTT, C. E.

THE SUB-STATION.

THE sub-station is the *raison d'etre* of the telephone exchange, for it is the machinery that enables the subscriber to talk. The switchboard holds the apparatus for connecting subscribers' lines together; the wire plant is the path that guides the electric waves along their predetermined course; but the sub-station is (in a sense)) the thing that does the *talking;* it is the vital organ of the whole plant, without which neither pole lines, cables, conduits nor central offices could have any existence. The sub-station contains the *telephone;* and this single expressive phrase exhibits the vital relation of the sub-station to the exchange as a whole. To injure the sub-station is to devitalize the wire plant, and paralyze the busiest switchboard.

As telephone exchanges are now constructed every sub-station must be designed to perform two functions that are inherently completely distinct and separate from each other. These are:

A. The Signaling Function.

B. The Conversational Function.

On a still further analysis it is easy to see that each of them is again divisible into two parts. Thus the signaling function must be arranged so that the subscriber can call the exchange, and so that the exchange can notify the subscriber. Similarly the conversational function must be so organized that the subscriber can talk to other

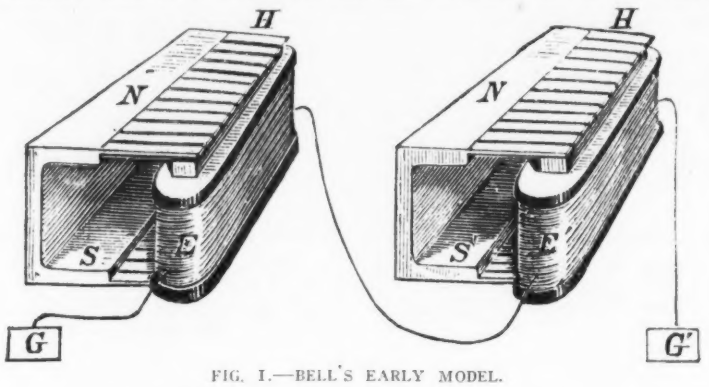


FIG. 1.—BELL'S EARLY MODEL.

parties, and so that he may receive conversation from others. Therefore, there are four grand divisions of sub-station apparatus:

1. The Apparatus for Receiving Signals.
2. The Apparatus for Sending Signals.
3. The Apparatus for Receiving Conversation.
4. The Apparatus for Transmitting Conversation.

Subordinate to this general classification come the subdivisions comprising the various methods used for the assemblage of sub-station apparatus, the wiring of the subscribers' premises, and such auxiliary apparatus as protective appliances, message meters, coin boxes and the like, the types of batteries to be used in local battery sub-stations, induction coils, etc., and finally the various general modifications necessitated by party line service.

It is now proposed to take up each one of these parts and examine what appears to be the best current practice in the construction of sub-stations, and the lines along which development seems likely to take place. The history of the telephone, and the theory of the interconvertibility of sound and electricity will only be touched upon collaterally in so far as it may be wise to the complete development of the subject, while for further information on these very interesting and important subjects the reader is referred to the many excellent treatises extant, in which they are fully developed.

THE RECEIVER.

The history of the human race is a record of a step-by-step progress. No Venus, excepting in the annals of mythology, is born of the sea foam in the full panoply of beauty, but each child slowly passes through the repulsiveness of adolescence, and develops into the attractiveness of maturity. To this rule of progress even the most wonderful inventions are no exception. They never burst in full glory upon the startled horizon of humanity, but from small beginnings develop gradually to most marvelous proportions, and it is only a retrospective consideration that reveals them in their true bearing, while the perspective of the past causes astonishment at the seeming rapidity of development. Under this great law of progress the telephone has evolved, and from an historic standpoint it is convenient to commence a consideration of the sub-station with the examination of the receiver, for in point of time it is the foundation of telephony.

Working in conjunction with his father, Prof. Alexander Graham Bell had, many years prior to 1875, been carrying on experiments to perfect some kind of apparatus to teach the deaf to speak, by imparting to them a notion of sound, or rather an idea of the use of the vocal organs, through other nervous channels than those of the ear. Through these studies he was led to consider the possibility of the electrical transmission of sound. Many experiments were

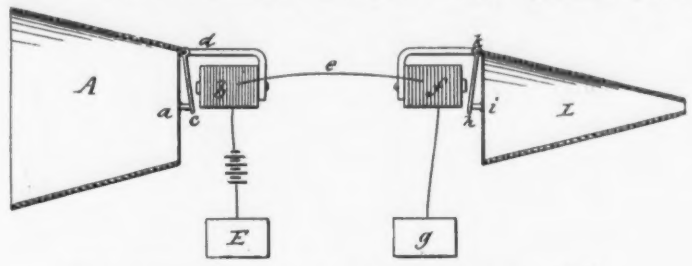


FIG. 2.—MODEL SHOWN IN PATENT OF MARCH 7, 1876.

tried with all kinds of vibrating circuit-breakers, which were attended with as little success as the similar efforts of earlier workers in this field. Finally, following an idea suggested by an apparatus built by Helmholtz for the artificial production of vowel sounds, Prof. Bell devised an apparatus illustrated in Fig. 1. A series of reeds, *H,* are secured to a frame, *N,* and are placed in close proximity to the poles of a magnet, *E,* surrounded by a coil of wire, the end of which extends to a precisely similar apparatus located at a distance. When any one of the reeds at the sending station was vibrated mechanically, the corresponding reed at the receiving station was sent in motion, and emitted a sound of the same pitch as the original one. If several of the reeds at the sending station were simultaneously vibrated a composite sound issued from the receiver. While the device shown in Fig. 1 bears little resemblance to the modern receiver, it is very evident that steel reeds, the magnet, coil of wire and line embraced all the elements of the modern receiver, and the instrument could certainly sing if not talk.

This harp-like affair was far too complicated to be of value. Perceiving this, the inventor strove to simplify, and on February 14, 1876, filed a patent application for an apparatus shown diagrammatically in Fig. 2, which is a reproduction of Fig. 7 of the famous Bell patent of March 7, 1876. At the sending station there is a funnel, *A,* to receive the sound waves, the small end of which was closed by a diaphragm, *a,* of gold beater's skin. The center of this was connected to a swinging iron armature, *c,* set in front of an electromagnet, *b,* while a battery, line and similar receiving station completed the outfit. For the first time this patent clearly and broadly describes the office of the moving armature, *c,* to vary the magnetic

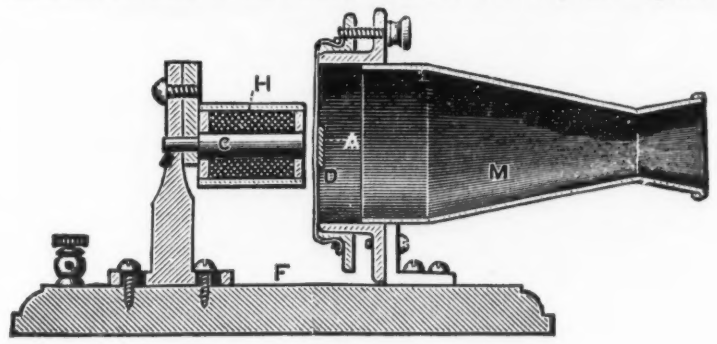


FIG. 3.—ARTICULATING MODEL.

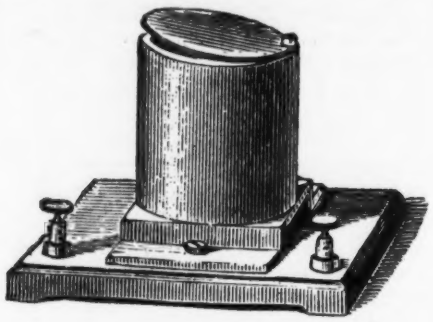
field in which it hangs, and thus originate an undulatory current in the line in distinction from the pulsating impulses of a circuit-breaking apparatus, though the model shown in Fig. 2 was still defective and failed to give good articulation by reason of the contact at *c.* The final solution of the problem was achieved in the instrument shown in section in Fig. 3. An electromagnet, *H,* was mounted on a baseboard, *F,* the circuit being extended to the binding posts. In front of the magnet a funnel was placed over the end of which, set directly in front of the magnet a piece of gold beater's skin was stretched. In the center of the diaphragm thus formed a small piece

of soft iron, *A*, was cemented, concentrically with the pole of the magnet. In this device one recognizes at a glance all the elements of the most modern telephonic receiver, and between the hand telephone of 1903 and the model of 1876, there is no functional change, the only modification being in mechanical details.

To even casually review the long, bitter and much-to-be deplored legal controversies as to priority of invention that at once arose between Bell and a host of would-be inventors, who, seeing that the problem of the electrical transmission of speech was solved, immediately desired either a share in the glory or to enviously destroy the deserved tribute paid to another, is entirely foreign to these paragraphs. Unfailingly have the highest legal tribunals accorded to Prof. Bell the full credit of the undulatory transmission of sound, and from such a verdict it is only the malicious that would even desire an appeal.

At the Philadelphia Centennial of '76 Bell exhibited other models, shown in Fig. 4, one with a double-pole magnet, and one in which the diaphragm is placed horizontally on a magnet supported on a base. To substitute a permanent magnet carrying a small wire coil for the electromagnet of the early types, and a thin iron diaphragm for the fragile gold beater's skin, is a bit of good mechanics, scarcely more, for the fundamental operation of the instrument remains unchanged. Such is the history of the birth of the telephone, for from these instruments has the entire art descended.

Consider now a little the theory of operation. Fig. 5 is a diagram-



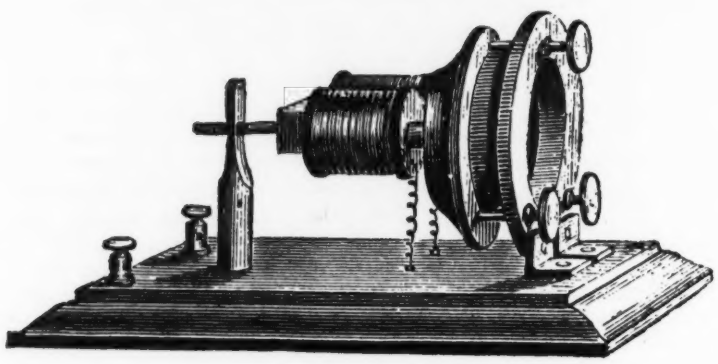


FIG. 4.—CENTENNIAL MODELS.

matic representation of a pair of magnetic telephones connected for conversation. Each instrument consists of a bar magnet, *N S*, on one end of which is a coil of wire, *H*. In front of the magnet is a thin iron diaphragm. These, then, the magnet, the wire coil and diaphragm, are the vital, and the only vital organs of the telephone receiver, though obviously there must be some kind of mechanical support to retain them in the relative positions shown in the sketch, and this support it will be found plays no unimportant roll in the successful operation of the receiver.

If any sound, articulate or otherwise, be produced in the vicinity of the diaphragm, the sound waves will impinge on the plate, and as this is thin and elastic, the impact of the waves will cause it to vibrate each excursion of the moving plate very closely, though not exactly resembling the sound wave that produced it. As the diaphragm is placed close to the magnet, *N S*, it is in a strong magnetic field, and thereby is magnetized. Experiment shows that any relative motion of magnets in close proximity to each other, disturbs and changes the magnetic field existing between them, and experiment also teaches that a coil of wire placed in a varying magnetic field becomes the seat of an e.m.f. that is proportional to the rate at which the magnetic field is changing. The magnetized diaphragm is moving synchronously with the sound waves that excite its motion, hence the magnetic field in which the coil of wire, *H*, is placed is similarly disturbed, and an e.m.f. correspondingly changing, and proportional to the rate of change in the magnetic field is set up in the coil. Suppose from the ends of coil *H* a circuit either by two wires, or by one insulated conductor and ground be completed to another precisely similar apparatus. The varying e.m.fs excited in the coil, *H*, will cause undulatory currents of electricity to traverse the circuit in which the coil of the second telephone is included. Experiment teaches that the magnetism of a bar magnet surrounded by a coil of wire carrying a current is changed approximately in proportion to the current passing; therefore, the magnetism of the second magnet will ebb and flow with the undulations of the current

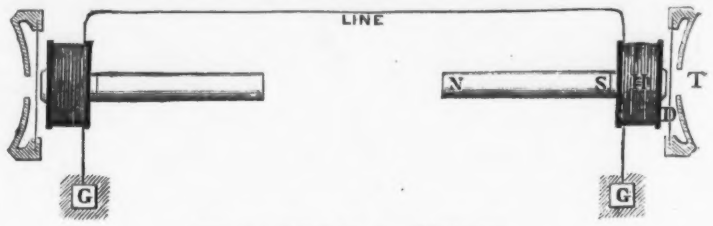


FIG. 5.—DIAGRAM OF OPERATION.

in the line wire. The diaphragm of the second telephone being in a similar magnetic field to that of the first one, is under a tension produced by the pull of the magnet. As this field is alternately weakened and strengthened by the reactions of the current in the coil, the stress on the diaphragm rises and falls, and with this flux and reflux obeying the laws of its own elasticity the diaphragm swings to and fro, repeating with wonderful, though not with absolute fidelity in shape, but displaced a whole period in time, the motions of the diaphragm, *T*. As the second diaphragm swings to and fro it carves the air into sound waves, and thus the second telephone faithfully reproduces what is spoken into the first one. This most remarkable and interesting cycle is one of the most convincing demonstrations of the law of conservation of energy and may be recapitulated as follows:

1. Sound waves impinge on the first diaphragm and set it vibrating.
2. The moving iron causes changes in the magnetic field.
3. The field changes excite undulatory e.m.fs in the wire coil of the first telephone.
4. These e.m.fs produce currents between the two instruments.
5. These currents cause corresponding changes in the magnetic field of the second telephone.
6. These field changes set the second diaphragm vibrating.
7. The vibrations of this diaphragm initiate air sound waves similar to the original ones.

Prior to Bell's researches much time and many experiments had been spent on an endeavor to transmit speech electrically. But all of the various pieces of apparatus devised were based on the plan of completely opening and closing a transmitting circuit with each sound wave; *vide*, the famous apparatus of Reiss, invented in 1861, which differed from Bell's only in this one very important particular. The Reiss telephone had a vibrating diaphragm armed with a platinum point that opened and closed a battery circuit with every pulsation. The line current from such an instrument would be represented by a diagram like *A*, Fig. 6, for with a make-and-break instrument, the current will be zero when the contact is open, and its full value immediately it is closed; there are no other conceivable

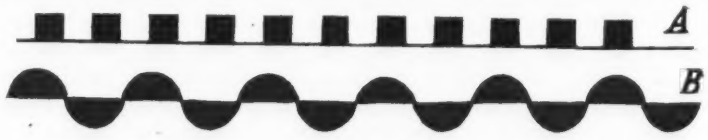


FIG. 6.—DIAGRAM OF PULSATING AND UNDULATING CURRENTS.

values. Such an apparatus can repeat a simple sound that consists of only one set of waves, like the note of an organ pipe, or that of a whistle. As there is only one contact it is obviously impossible for it to do more. But in the voice there are coincidently many vibrations varying both in number or pitch, and in amplitude or loudness. Such complexity a simple make-and-break cannot repeat. In a diaphragm free to vibrate in a magnetic field the limitations of the make-and-break are removed, and such an apparatus causes a current that may be represented by *B*, Fig. 6. Here there is a delicacy obtained capable of reproducing all of the infinite gradations of vocal

utterances. In 1875-6 very little was known of magnetic fields and the intimate reaction of current and field. So all the more credit is due to Prof. Bell for the contrivance of an apparatus which depended on *undulatory* currents without which complex speech cannot be reproduced, and the courts have always held Bell's invention to consist in the *undulatory* current, or rather its electro-mechanical production and utilization in the transmission of speech.

An examination of the sound waves emitted by the voice in speaking shows them to consist of a basic or fundamental tone, relatively low in pitch, but of great amplitude or loudness, on which are superimposed a large number of harmonics or over-tones, that consist of vibrations two, three or four times as rapid; all correspondingly higher in pitch, and of small amplitude.

It is the presence of these over-tones, and the relative proportion and intensity of each one that endows different voices with their distinguishing properties, and enables one to infallibly recognize the tone of a friend. As the quality of the voice depends in each case on the relation between the fundamental and each of the many over-tones, it is essential, in any speech transmission, that this ratio should be most exactly preserved. If the short harmonic waves were transmitted faster than the fundamental, speech would presently become unintelligible, for a portion of one word would thrust itself into the middle of the preceding one. There is, however, little to be feared from this contingency, for while there is a perfectly measurable and accurately known amount of time consumed in the transmission of every telephone wave, each portion of every word, of every syllable,

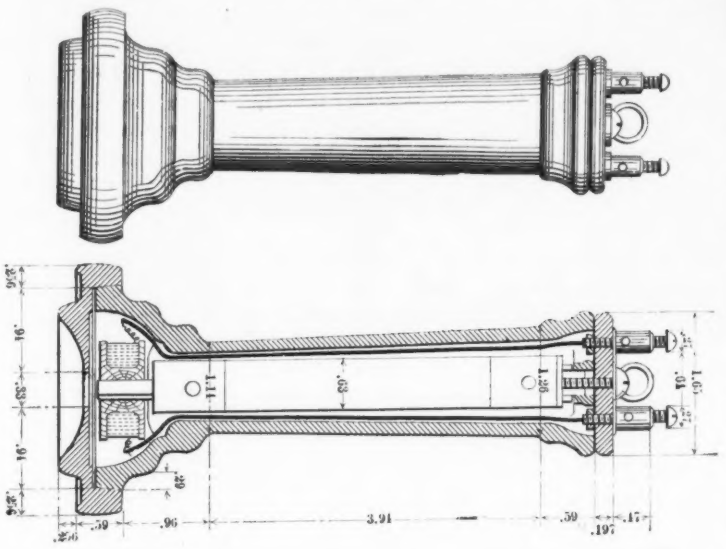


FIG. 7.—SINGLE-POLE BELL RECEIVER.

of every letter, is equally retarded, and though all are delayed, the ratio of delay for each is constant.

The mental impression produced by any sound depends on the number of vibrations per second (the pitch) and the square of the amplitude, or distance through which the wave rises and falls. It is for this reason that a high, shrill voice attracts more attention than a deep tone. A change in the amplitude (which varies the loudness) does not alter the pitch, but it does produce a very great change in the metal impression produced by the sound. If the amplitude of all the waves of a composite sound like the voice be uniformly changed, the ear at once knows that the sound is more or less loud, but is equally sure that its distinctive quality is unchanged. If on the contrary the waves of some of the harmonics are reduced more than others the sound entirely loses its characteristics, and the ear fails to recognize its source. Therefore, in telephonic transmission the *relative amplitude* of all waves must be exactly reproduced or speech will be unintelligible. It is perfectly legitimate to reduce within certain limits the amplitude of all waves and thus equally decrease loudness. But to change some waves more than others is to destroy characteristic quality. Unfortunately this is exactly what does occur, and moreover this distortion takes place not only in the receiver, but also in the line and the transmitter, and in an endeavor to eliminate this distortion, much investigation has been spent, with as yet but very partial success.

As the receiver is now used in telephony, its function consists in taking from line the undulatory waves of electricity impressed thereon by the transmitter, causing them to vary the field of a permanent magnet in which a diaphragm is suspended capable of vibrating with the field changes. *Ceteris paribus,* that receiver is the best whose electric, magnetic and acoustic properties are such that the sound waves emitted by the diaphragm correspond most closely in amplitude, shape and energy to the electric pulsation of the line, and the three organs of the receiver, the coil, magnet and diaphragm must be so planned in relation to each other as to secure this result.

Unfortunately, systematic investigations of the principles of the receiver designed from such a point of view are very meagre. In America, the most extensive studies are those undertaken at the Massachusetts Institute of Technology by Messrs. Cross, Williams, Hayes, Mansfield and Phillips and reported in the proceedings of the American Academy of Sciences.[1] A somewhat similar study was undertaken by Mercadier[2] in 1889. Other limited investigations have been made by Blake, Salet[3], Fröhlich[4] and Franke[5].

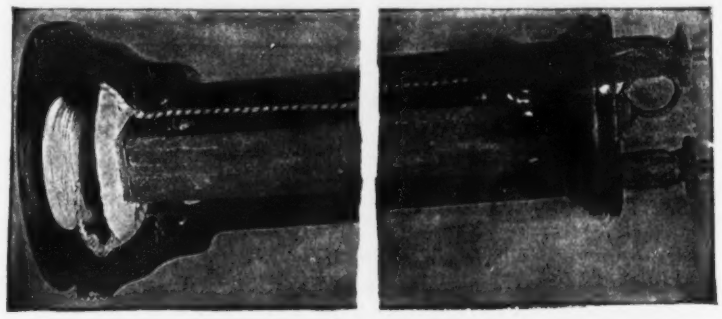


FIG. 8.—SECTION OF BELL RECEIVER.

Aside from these investigations there seems to have been little attempt to formulate a scientific receiver design. For a long time the American Bell adhered to the single-pole type, a dimension drawing of which appears in Fig. 7 and a photograph of a section in Fig. 8. Several years ago this company commenced to use the bi-polar design, shown in Fig. 9, which has proved itself so decidedly superior to single-pole that the latter has nearly disappeared. The American Bell has always been exceedingly averse to the diffusion of telephonic investigations of any description, so it is not surprising that there is little information extant as to the construction of this receiver.

The Bell receiver was, and is by no means perfect, and owing to excessive conservatism, it has changed little since the bi-polar type was adopted. The younger companies have been more flexible and quicker to profit by experience, and there are many Independent receivers that are far superior to the Bell in mechanical design, and several in which both the mechanical design and shop execution are far better, but in electric, magnetic and accoustic properties, the Independent instruments are less successful, for there are few receivers that talk as well as those of the American Bell, and only two or three that can be said to be perceptibly superior. The Independent Companies have been so occupied in catching up to telephone business that they have had little time for systematic study along scientific lines, but the time is now ripe for an investigation of the

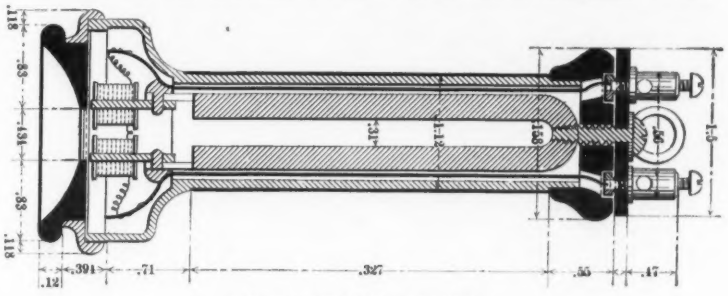


FIG. 9.—BIPOLAR RECEIVER.

principles of receiver design. Competition is slowly but surely awarding business to those who do it best, and he who is sufficiently altruistic to do some missionary work in this field will surely reap a reward.

---

[1] See proceedings of American Academy of Sciences, Vol. for 1888, Page 113; Vol. for 1890, Page 233; Vol. for 1892, Page 93; Vol. for 1893, Page 234.

[2] See Comptes Rendus, Vol. cviii, Pages 735, 797. 1889; Vol. cxii, Page 96. 1891; Vol. xcv, Page 178. 1882.

[3] See La Lumiere Electrique, Vol. xxv, Page 180. 1887.

[4] See Elektrotechnische Zeitschrift,Vol. xl, Page 228. 1890.

[5] See Journal Society of Tel. Eng., Vol. vii, Page 247. 1878.

Telephone Development in the Philippines.

SINCE the successful establishment of telephone systems in Manila and suburbs, there has been considerable demand for the introduction of like systems in places like Iloilo, Cebu, Zamboango and places of equal importance in the Philippine Islands. The Signal Corps of the United States Army has done a wonderful work towards this problem by introducing government telephone lines at many points, but these of course are for the use of the military. Commercial concerns and individuals have the use of these military lines only as a matter of accommodation. The business men of the important islands and cities want lines put in

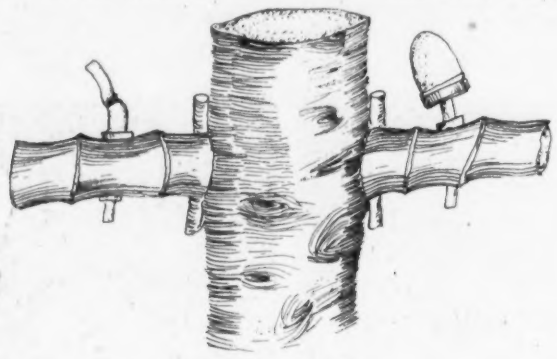
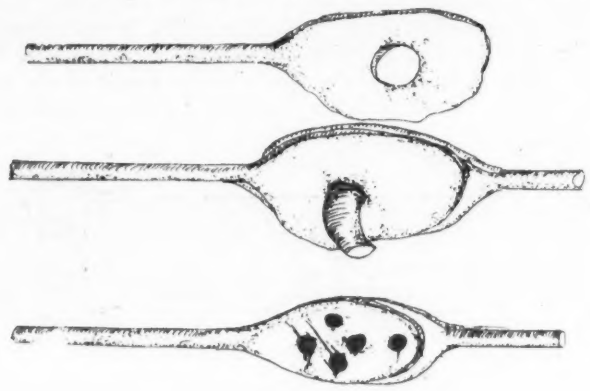


FIG. 1.—CROSS ARM.

specially to conduct the business of the localities. Take for example Iloilo, where the business men have been taking steps towards getting a telephone line in for months past, there are some 30,000 inhabitants, making it the second largest city in the islands. At present the "Muchachos," or native servants, are employed to run with notes and messages, but these people are exceedingly slow. Adjoining Iloilo are Jaro and Moro, and considerable capital is represented in these places. The writer remained several weeks in Jaro and became satisfied that subscribers enough could be obtained in this one place to start a line with an abundance of capital. In fact there are prospective investors in all of these places.

The Spanish had their lines of telegraph and telephones established in the leading commercial centers, and the natives were often employed to do the work on the line and in caring for the instruments. The writer found that the native lacked ingenuity in this line of operation, and does not seem capable of making repairs so skilfully as the American lineman. To give the reader an idea of the pattern of one of the native poles, cross arms and fittings, Fig. 1 is presented. The pole is usually a cocoanut trunk. These poles can be cut the required length, and as they are without branches except at the top, the work of preparing them for use is light. A pole can be



FIGS. 2, 3 AND 4.—WIRE JOINTS.

got ready very quickly after it is felled. Then a hole is gouged through with crude native tools and the bamboo cross arm inserted as shown. The insulators in these arms are usually out of line, broken off, or otherwise disordered.

The native linemen have but very few tools with which to work, which often accounts for the poor work done by them. It may interest readers to notice the system of making unions of ends of wire as employed by the native lineman as taught, undoubtedly, by the Spanish. The writer saw that one lineman, in endeavoring to make a simple joint of two pieces of the line had laboriously hammered out the stubs, as shown in Fig. 2, until disks were formed. Then he slowly and carefully used his hand drill to make the hole through these flattened ends. Then he placed one above the other and inserted the bit of wire, as in Fig. 3. This made a union. Another form they use consists in boring several holes through the sides and inserting a pin in each, as in Fig. 4. The native linemen are not liberally furnished with any of the metallic or glass or other parts of the apparatus used in the line work. It seems to have been the custom to start a line in operation and then the engineers would leave it, and not an extra part of any sort would be provided. Consequently, one sees old bottles used for insulators, and all sorts of metal devices employed in one way and another.

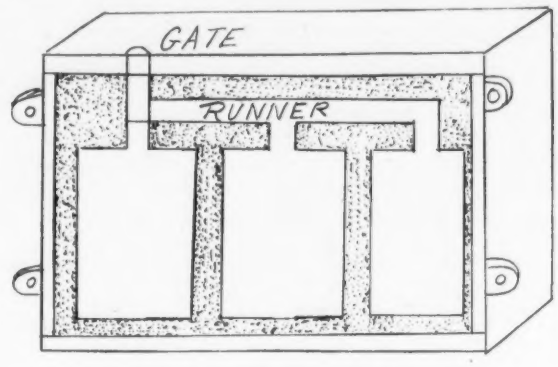
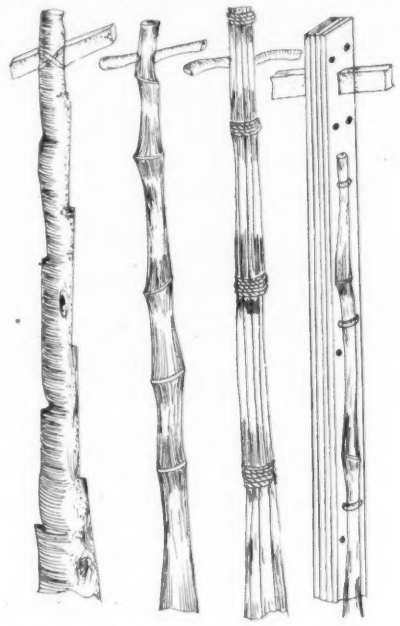


FIG. 5.—MOLDING FLASK.

In one place the natives employed at line work possessed a device for casting metals into required form, such as is shown in Fig. 5. The affair is an old Spanish molding flask, with gate and runner to receive and carry the metal to the molds, as represented. This device the natives used in varied form by molding the sand to the needed pattern desired to cast.

The types of poles used in the Philippine Islands, both for the telephone service and telegraph are notable curiosities. Fig. 6 shows the cocoanut style of pole, previously mentioned. It will be noticed that there are notches cut into the sides. These form the steps by which the native lineman ascends and descends the pole at will. He is barefooted and can go up and down the pole very easily, even when carrying tools and equipments on his shoulders. The cocoanut



FIGS. 6, 7, 8 AND 9.—TYPES OF POLES.

wood seems to stand the climatic and noxious influences of the ant-filled earth well. Unless the ants conclude to nest in the wood, the trunk will last for years.

The common bamboo type of pole is exhibited in Fig. 7. It is a very convenient pole, readily obtained along the route, and always strong, reliable and straight. For permanent service, however, the bamboo pole is not used. It is suitable for a temporary line, say for six months or a year. After that the poles usually weaken and fall. There is a system of binding up a series of small diameter, but lengthy pieces of bamboo employed, as illustrated in Fig. 8,

which is considered effective. The natives collect the required lot of bamboo together and bind it up, with cordage, as shown, resulting in a substantial combination. Another form is illustrated in Fig. 9, consisting of four or five separate pieces of boards joined with wood

FIG. 10.—TELEPHONE OFFICE SIGN.

pegs. The cross arm is inserted through the top. Sometimes, to add to the strength of the pole, a piece of bamboo is extended along the sides, and secured with bamboo fastenings. The native is not without the sign indicating the office of the telephone system, and this sign is in varied languages or separate signs are used, each

FIG. 11.—NATIVE LINEMAN.

with its appropriate wording. Fig. 10 is one of the artistic inscriptions of this order. The native has some fantastic ideas concerning finishing and decorating signs and he applies them freely. These are some of the ways and ideas relating to the old style and the new style telephone systems as observed in the different portions of the

FIG. 12.—AMERICAN CAMP WITH DOUBLE POLES.

Philippine Islands. Where the line is operated exclusively by Americans, you even then see the handiwork of the native, because as a rule the native is the handiest and cheapest man available for this line of work.

Dutch Cable at Guam.

Permission will be granted to a Dutch cable company to land on the Island of Guam a cable from Marshall Island. Guam is to be a relay station in the transpacific cable. There was some objection to the first application of the Dutch company on account of the position desired for its cable office. The cable from Marshall Island to Guam will probably be laid before the transpacific cable is completed, and the Navy Department will in a short time be able, by using the German cables in the South Seas, to send orders by telegraph to the naval Governor of Guam, at Agana, which is now connected with other ports only by steamer. By next September it is expected that there will be communication with Guam by the all-American cable of the Commercial Pacific Cable Company.

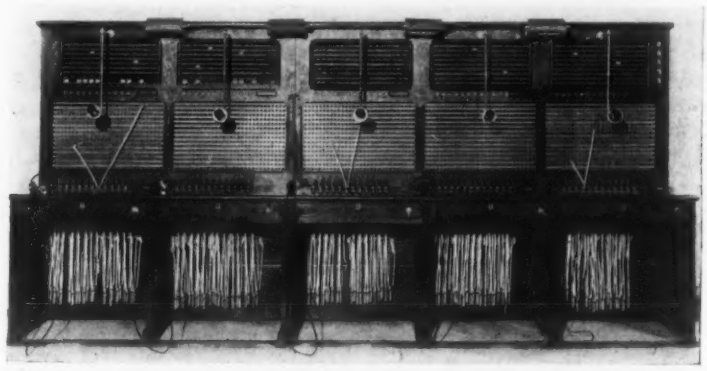
Telephone Service in New York Hotels.

In recent articles in these pages on the development of telephony in New York City, attention has been directed to the remarkable growth of the art in connection with private exchanges in commercial offices and especially in hotels and apartment houses of the more important class. The increase in the use of the telephone in New York in every direction has, indeed, been remarkable, but doubtless the feature of telephone development for the past year, which stands out most prominently, is the manner in which the service has been adopted at hotels. Since January 1st, 1902, contracts have been taken covering a complete long-distance telephone service for every room and working department in the following hotels:

Name.	Number of telephones.
Hotel Manhattan	678
Hotel Imperial	575
Hotel Astor	550
Plaza Hotel	400
Hotel St. Regis	389
Fifth Avenue Hotel	360
Ansonia Hotel	360
Holland House	350
Hotel Victoria	300
Marie Antoinette	300
Hotel Marlborough	300
Astor House	275
Buckingham Hotel	184
Hotel Vendome	175
Westminster Hotel	170
Hotel Lorraine	160
Hotel Endicott	150
Hotel Empire	150
Wellington	145
Hotel Belleclaire	145
Hotel Collingwood	135
Gregorgian	135
Winsonia	130
San Remo Hotel	130
Hotel Martinique	128
Hotel Cadillac	120
Algonquin Hotel	120
Somerset	115
Lenori	114
Seymour	100
Hotel Lafayette-Brevoort	100
Hotel Grenoble	100

And forty others ranging from 50 to 100 stations.

Except in cases where the hotels are not yet completed or opened for business, the service has been established and the manner in which it is used by the hotel guests from their rooms shows the very great favor with which it has been received. The traffic in



SWITCHBOARD IMPERIAL HOTEL, NEW YORK.

nearly every case has exceeded the original estimate; in some cases it has been necessary to increase the number of central office trunks.

In planning important hotel installations, such as those above mentioned, a study of the situation is made by the Traffic Department of the New York Telephone Company, and switchboard equipment is installed in accordance with the estimates made by that department. The total switchboard equipment designed to cover the thirty-two hotels mentioned above covers eighty-seven operator's positions; the ultimate capacity is for 13,500 lines and the number of central office trunks contracted for is 320. We illustrate herewith the switchboard installed at the Hotel Imperial to take care of the equipment of no fewer than 575 telephones furnished there.

Corrosion by Electrolysis.

AT the meeting last week of the American Electrochemical Society, Mr. A. A. Knudson, in a paper entitled "Corrosion of Metals by Electrolysis," considered the subject under the heads of galvanic action between dissimilar metals, and destructive effects of railway current on subterraneous metals. Of the part of the paper under the second head we give an abstract below.

A brief historical résumé was given as to the results of some surveys and tests made during the past few years in the City of New York. In the spring of 1897 Mr. Knudson discovered, while making an electrical survey in Manhattan in behalf of one of the railway companies, that a portion of the return railway currents generated at the Kent Avenue Power Station in Brooklyn, E. D., passed over the New York and Brooklyn Bridge to underground pipes in Manhattan. At that time it was supposed that these currents took the shortest and most direct path through these pipes back to Brooklyn, taking to the river in the vicinity of Grand Street, about opposite the power house, which is located on the water front in Brooklyn at Kent and Division Avenues.

In October, 1898, while making further measurements on the bridge, practically the same electrical conditions were found, viz.: currents from Brooklyn flowing over the bridge and down the pillars in Park Row which support the terminal structure and the elevated railway station, and from them to water and gas pipes in the street. In the early part of 1899 Mr. Charles R. Barnes, electrical expert for the New York State Railway Commissioners, made at their direction an extended survey through the Borough of Manhattan, and found the electrical conditions at the bridge and other points in the city practically the same as we found them in 1897 and 1898.

In the month of May, 1902, a further survey was made in this section of the city, for the purpose of ascertaining if currents of electricity flowed through underground pipes, what direction they were taking, and their identity and source. It was discovered that a portion of the Brooklyn railway currents generated at the Kent Avenue power station, in their return to that station pass over the New York and Brooklyn Bridge to Manhattan, thence flow through underground pipes as far north as Twenty-third Street, and flow east towards the river through pipes in streets running east and west, and also returning over the new East River Bridge. On the Brooklyn side of the river the currents were found to be leaving the river, and passing into the underground pipes as far north as Greenpoint at about opposite Twenty-third Street, Manhattan, thence flowing south to their starting point, the power station in Kent Avenue.

One means of identifying this trolley current was by a test during the so-called rush hours between 5 and 7 o'clock in the evening, at the foot of Twenty-first Street, between a pipe connecting with the gas mains and the river; the rise in voltage indicated when the cars are carrying the heaviest load, a little before and after 6 o'clock, and the falling off as the load becomes lighter. The maximum voltage of 1.2 volts, occurred several times between the hours of 5.30 and 6.30 P. M. The same test was made between one of the pillars at the Manhattan terminus of the bridge and a water pipe, on the following evening, where the maximum difference of potential was 3.6, this also at the same time as the previous test.

Potential readings through the streets were obtained by connections between gas posts upon the gas mains, and between hydrants on the water mains, using a millivoltmeter. A higher reading instrument was used for other tests. A few current readings were made upon pipes found exposed in the subway in Elm Street. In 1902 5.9 amp. were found flowing north upon a 12-in. pipe near Grand Street. This year, upon a 20-in. main a little north of Canal Street, 6 amp. were found flowing north; this, however, is only a portion flowing north, as it was found that current is passing through the metal of the subway as well. One point of contact between this 20-in. main and subway metals was discovered where a hub of the main rests against a girder just north of this point. On the other, or south side of Canal Street, no reading could be obtained, the cause being that this main came to a dead end about a block below; beyond the dead end for about half a block the main had been removed, current, therefore, passing north from the bridge by way of the metal work of the subway; thence just above Canal Street 6 amp. of it is transferred to the 20-in. main; how much more is passing through the subway structure cannot be ascertained, but the most of this same current no doubt finds its way through subway metals and pipes to and over the East River Bridge, while a smaller amount is spread through the pipes and passes by way of the river bed to the power station. The maximum readings a year ago between a hydrant and the structure were 5.4 volts; now they are 6.5 volts and 6 volts from the gas mains. On the Brooklyn side the test a year ago was 7.2 volts, the direction of flow being from bridge to pipes; this year the reading was only 0.5 volt. The reason for this much lower difference of potention than last year on the Brooklyn side was owing to the conditions being changed, viz., a 6-in. wrought-iron pipe is now led up to, and rests upon, the steel girders of the roadway, making a fairly good connection between the bridge structure and the water piping of the borough.

This pipe supplies the engines upon the roadway with water. A current measurement (using the "fall of potential method") was taken upon that portion of this pipe which is close to the ground, and a maximum flow of 69.5 amp. was found passing off the bridge through this medium to the Brooklyn mains. This current flow was determined later by a test at Columbia College upon a pipe of the same size. This current found entering the mains in Brooklyn must again leave them in its course to the power house, and it is well understood that at such points where the current passes into the soil, electrolytic corrosion of the iron occurs.

Further tests between the structure and pipes in Brooklyn were as follows: About one block from the river, difference of potential, 2 volts; bridge positive to mains. Two blocks from the river, 2.5 volts; same direction of current. These latter tests indicate that by no means all of the current which passes over the bridge to Brooklyn, which is considerable, passes throug the 6-in. pipe, that is but one outlet; other outlets are such parts of the metal structure as may connect with the earth, where the resistance is sufficiently low, and at such places corrosion is possible.

The new bridge is, therefore, taking the larger portion of straying railway current, which formerly passed through the underground pipes in Manhattan to the north, or in other words it is in such position that it invites a more direct return path for these currents to flow back to the Brooklyn power station. This new return path will continue to improve as a conductor, as the bridge nears completion, when more current will be diverted in this direction, unless some method is devised to control it; the readings taken this year were made after the roadway had been joined, which may account largely for the increased flow indicated over last year.

It has been known for some years that pipes in the Navy Yard have been destroyed from time to time, by electrolysis, evidence of which we have seen in a number of samples shown us during recent visits. Wires have been run from a central station connecting with the water mains at different points; by this method the difference of potential can be taken between any two points in the system, and there were 14 of these connections. The direction of the railway currents is always towards the power station, which is located just across the channel from the cob dock. The most of the pipes which have been destroyed were in the cob dock. At one time it was feared that the steamship *Columbia,* used as a receiving ship, was being damaged on account of being in line of these currents, but we are reliably informed that the plates of this ship were carefully examined when the boat was recently in dry dock, and no action except what might be expected from sea water corrosion was discovered. The difference in potential now between points on the sides of the yard near Flushing Avenue and Navy Street, to the point nearest the power station, is 20 to 25 volts; formerly it was higher than that.

The railway company suggested that the damage caused, and being caused, to the pipes underground was not due to their currents, but was caused by the Navy Yard's own electric light and power circuits, which is of large capacity. While the officials were morally certain that the currents causing damage were from the railway power station, the question remained uncertain until the day of the late President McKinley's funeral, when the Kent Avenue power stations, as well as all others in the country closed down for five minutes.

It occurred to some of the engineers of the yard that it would be a good plan to make a few tests at that time, and while the lighting and power circuits were running, and the railway power station closed down, this was done. It was found that the voltmeter needles remained at zero at every test that was made, proving conclusively

that the currents causing the damage emanated from the railway power station.

Several water and gas mains have burst in Brooklyn, owing to electrolysis. An 8-in. water main which burst in Flushing Avenue near the Navy Yard Hospital grounds July 14, 1899, had all the characteristics of electrolysis, viz., the soft state of the iron in several plates which was reduced to a condition of graphite, easily shaved with a pocket knife. The voltmeter readings taken from where this pipe was removed showed it positive to the rails; besides it was resting in wet soil. The pipe from which this sample was taken was of the Scotch iron make, which is identified by the bulging rings found on every length; they are from 3 to 4 in. wide. Subsequently to the bursting of this main at this point, there have been three other failures upon the same pipe in this street within short distances from each other. Two of these damaged sections were in practically the same condition as to holes and soft spots as the pipe above referred to. There is no doubt, therefore, that all of these four failures were caused by electrolysis.

A few years ago an impression prevailed to some extent, that underground mains in Brooklyn were immune from electrolysis. Some gave as a reason that, as many of the mains were made of Scotch iron, there was something about the construction of that metal which resisted the effects of electrolytic action. Another reason was advanced by Prof. Sheldon, who discovered that a thin "silicious compound" of the nature of glass is found upon the surface of pipes, and formed there during the process of casting, which is the "true cause of immunity" as that material is an insulator. In view of the fact of many failures of pipes in Brooklyn since 1899, due to electrolysis, Mr. Knudson considers that neither of the above reasons as to immunity will stand. Prof. Sheldon also states that this coating is extremely thin and contains perforations. Such a condition is a good reason for an earlier rupture of a main, than if the corrosion were more evenly distributed over the surface, as at the perforations or spots where there is no coating, the action would naturally localize, and the iron be penetrated more rapidly.

In the large majority of electrolytic effects upon cast-iron mains, those spots that are longer one way than another, very frequently take a position at right angles to the length of the pipe. These lengths of pipe while being handled are often rolled over other lengths or hard surfaces, and this may cause a removal of the coating spoken of at such spots, and the consequent localizing of electrolytic action, which follows the line of the bare iron. This is a suggestion of a further reason that such coating is present, although we can find no comfort as to its presence being a remedy against electrolysis, but rather the reverse. On a chart showing the entire surface of a 12-ft., 48-in. main taken from a street in another city, there were 80 furrows and pittings, caused by electrolysis. Of the 80 which showed a length as well as breadth, all but 5 (which were quite small) were transverse with the length of the pipe. One was over 2 ft. long and 5-16ths of an inch at its deepest point. Others were shorter and some deeper, the deepest being 9-16ths of an inch.

Our view of the case, therefore, is that electrolysis has been getting in its work upon the Brooklyn mains for several years. If the action has been slower than in other cities it may be due to heavier rails or more improved return. The absence, however, of frequent failures of mains from this cause, should not be taken as evidence that electrolysis does not exist; its progress may be slow, slower in some cases than in others. The extent of such progress, however, will not be discovered unless looked for. A main may be nearly ruined by this action, but, owing to the pressure of surrounding soil, will hold together and not reveal its state through final bursting for a long time; hence there are many places in Brooklyn to-day where this process exists in all its stages, from the small pitting of ⅛ of an inch deep, to those that have penetrated through the mains which are leaking and about to collapse.

The only complete solution for electrolytic corrosion of underground metals by railway currents, is what is commonly known as the double trolley. Such method has been in use for some years in the Borough of Manhattan, N. Y., as represented by the underground conduit system; also in Washington, D. C., where the same system prevails in the city proper, and the overhead double trolley upon some lines in the suburbs, with convenient appliances for changing from one system to the other.

The section of New York under consideration is peculiarly situated geographically—considering also the location of the power house—for the returning currents to take the course referred to. Perfect immunity from possible electrolytic action upon the subterraneous metals of the two bridges, and the actual effect upon portions of the piping system in this section of the city, can only be had either in the method referred to, or a removal of these currents to some other section of the city. Modifications of the present grounded system tending to reduce the straying of railway currents may be undertaken, but changes looking to modifications only should not be accepted by the authorities as final, or relieving the railway companies in any way from further responsibility in the matter. It is commonly reported that the Kent Avenue power house with its 12,000 hp is to be enlarged to many times its present capacity.

Meeting of the Chicago Electrical Association on Overhead Distribution.

Mr. H. B. Gear, the general inspector of the Commonwealth Electric Company, read an instructive paper on the Overhead Distributing System of the Commonwealth Electric Company, before the Chicago Electrical Association Friday evening, April 17. The paper in a general way covered the problems involved in the distribution of current by overhead lines. Mr. Gear considered these problems both from an economic and from an engineering standpoint. He called attention to the fact that although the greater portion of the territory within the corporate limits of the City of Chicago was covered by overhead lines, the amount of energy distributed from the overhead and underground systems, varied approximately in an inverse relation. This necessarily calls for an alternating system of distribution. The lighting feeders, as a rule, are single-phase, while motors are operated from three-phase, four-wire circuits, which also carry single-phase motors in many cases. Because of the rapid growth of the business the expansion of the system of mains necessarily has been great. This necessitates periodical arrangement of the feeder system, to provide for changed conditions. The calculation of feeders has led to a study of economic considerations, which should be kept in mind in the design of the same.

The annual cost of maintaining single-phase feeders is composed of the two elements that are common to electrical apparatus, namely, operating cost and fixed charges. These are related to each other in an inverse manner, so that any cause which results in the increase of the one produces corresponding decrease in the other. There is, therefore, a point at which the sum of these is a minimum for any given set of conditions. The operating cost of a feeder transmitting electric current consists of the expense of repairs and the value of the energy which is distributed on the feeder between the station and the center of distribution. The repairs are practically independent of the size of the wire used, and may, therefore, be disregarded in these calculations. The value of the energy lost in the feeder is, of course, dependent on the cost of energy per kilowatt-hour delivered at the station switchboard. The energy lost on the feeder is dependent upon the average daily load factor of the current transmitted over it. The maximum load and the average daily load factor being assumed, the annual output of the feeder may be readily calculated. Assuming various sizes of wires to be used on this feeder, the value of the kilowatt-hour loss may be determined.

The value of any theoretical calculation to the practical engineer lies chiefly in the fact that the principles underlying the theory are set forth so that in any practical problem the engineer may know whether his work is tending toward the ideal case or away from it. Practical conditions rearely coincide with ideal cases, and the engineer can, therefore, only approximate his work to the theoretical case as nearly as may be.

The transformer, the connecting link between the primary and secondary distributing systems, has been the occasion of much discussion among central station men during recent years. The installation of separate transformers for each building into which service was introduced has been the rule in the past. This resulted in the installation of a very excessive amount of transformer capacity in small units. The large all-day losses, which were the inevitable result, eventually directed the attention of manufacturers to the necessity of a study of these losses. The use of the transformer has, therefore, passed through a career of evolution which is no doubt familiar to all. In this evolution a large number of plants have found it advantageous to scrap their entire equipment of line

transformers, and replace them with modern apparatus. In connection with this work secondary systems have been installed, this allowing a material decrease in the number of transformers required, and an increase in the average capacity per transformer. There has, however, been a considerable variance in the practice of companies throughout the country as regards secondary mains. Some have installed a heavy three-wire network, inter-connected, throughout, whereas others have invested in secondary main capacity less heavily, inter-connecting only a few heavy lines along business streets, and using isolated transformers for more scattered districts. Still others have lagged behind the march of progress and are adhering more closely to the pioneer method of installing transformers very closely, with only occasional pieces of secondary work. Calculations have been made to ascertain the exact point at which the core losses of transformers are offset by fixed charges on the investment in wire and transformers at different loads. These have shown uniformly that smaller wires than are ordinarily employed give the best results. Of course the density of the load and its nature will determine the most economical size to be employed. Conditions arise which modify the general conclusions reached; but the calculations serve to furnish a basis for the formation of judgment as to the best policy to be pursued in handling this class of work.

The selection of the transformer equipment to supply an overhead system is of great importance. Inaccurate judgment as to what capacity is requisite may lead to an excessive installation, thus increasing both investment and operating expenses unnecessarily.

It is apparent that the lights connected to a transformer in a residence will not require the same capacity in lights connected as those in a store or factory. There are five classes of lighting, which require separate treatment in the selection of transformers: (*a*) large residences, (*b*) apartments and small residences, (*c*) stores, (*d*) factories, and (*e*) churches. The power factor of the load, the nature and the duration of the loads, the requirements of good service and other factors enter into the selection of the proper size. The Wright demand indicator, connected in circuit with a transformer, has been found to be a valuable aid in getting exact data as to the load being carried in any particular case. There are numerous minor problems involved in the distribution of current, but which nevertheless require careful treatment.

In a short discussion which followed attention was called to the fact that although theoretically three factors enter into the calculations for determining the size of a wire, only one as a general rule is considered in practical work, and that is the size of wire which happened to be in stock. Although it is important to take up the mathematical side of the subject, it should not be forgotten that after all the earning power of any installation is the most important.

The next meeting, which will probably be the last one of the present season, will be held at the Albion Café.

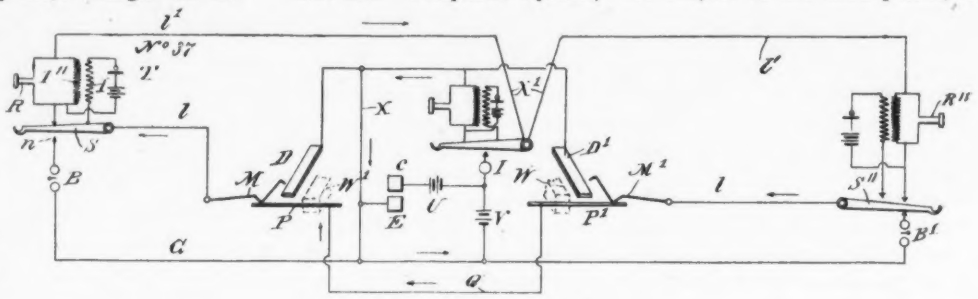
New Telephone Patents.

The three telephone patents of the issue of April 14 have for subjects a strain insulator, a manually-operated message register and a switchboard system so designed that even with metallic circuit lines only single strand cords are necessary in making connections.

The new strain insulator, which is designed primarily for use in guying line wires away from obstacles, is the invention of Mr. C. Claydon. For such work in the past it has been customary to use a porcelain or glass knob having a central aperture with flared ends and having a groove about the middle of its length. The guy to the line passes about the insulator, lying in the groove, while the guy toward the support is passed through the hole. With such an arrangement the line wire is effectively insulated from the guy support. Mr. Claydon's insulator is based upon the same principle, except that instead of the usual hole the attachment for the line guy is a loop of wire about a portion of which the insulator knob is cast while in a molten state. The twisted joint made in forming the loop serves well to retain the loop securely within the insulator, and to make the retention of the loop doubly sure, the ends of the loop wire are bent outward and cut off at the surface of the insulating block.

Mr. W. Gray has patented the new message counter, which is of that type in which by means of a key left in his possession, a subscriber may turn his register and count one message, at the same time signalling the operator that the proper record has been made. The most novel features of the present register embrace the use of multiplying gearing between the key arbor and the recording device, and the use for this latter of the ordinary bicycle cyclometer. The multiplying gearing gives a characteristic buzzing sound, which notifies the operator that the record is being made, while a stroke of a gong signifies at just what time the count is complete. By the use of a standard article like the cyclometer, the necessity of manufacturing a special counter is obviated.

The new "Telephone System," the subject of the third patent, is shown in diagram in the accompanying figure. As will be readily observed, the spring jacks have but one contact spring, which in its normal position bears against a contact plate common to all jacks. This contact plate serves as an operator's listening circuit, which will be broken by the insertion of a connecting plug. The operation of the system is analogous to the old Law system in its first stages, and analogous to the early annunciator systems in its last stages. Thus, when a subscriber desires to call, he removes his receiver from the hook and at once speaks to the operator through his own line and spring jack. The operator, to call the desired number, inserts a plug in the called-for line jack, say plug *P'*, and with the mate plug, *P*, taps the block, *C*, sending out current through the bell of the desired station. She then touches the plug, *P*, to block, *E*, and then listens for the subscriber to answer, whereupon she completes the connection with this plug, *P*, by inserting it in the line jack of the calling line. This last act disconnects the operator. Annunciators are provided to indicate the desire for disconnection, signified by the return of the receivers to the hooks at the respective stations. The operating disadvantages would prohibit the use of such a system in large installations, while it is only in such installations that the saving in cost of apparatus is important. The patentee of this system is Mr. T. Paul, of Canada.



PAUL TELEPHONE SYSTEM.

An Electric Moving Platform Between New York and Brooklyn.

The moving platform from Bowling Green across to Williamsburg Bridge, including a proposed subway from the Battery to Delancey Street, is being pushed as a business enterprise. Schmidt & Gallatin, who are making the proposals for the syndicate, say that three plans were originally made to the Rapid Transit Commission by the syndicate. These were:

1. The city to build the subway and the sidewalk company to guarantee a one-cent fare during rush hours and a two-cent fare for other hours. 2. The city to build the subway and the company to pay to the city 4¼ per cent. on the investment and to obligate itself to make a two-cent fare at all other hours. 3. The company to build the subway at its own expense and be allowed a two-cent fare at all hours.

The third plan is the one now being considered by the Rapid Transit Commission. The plan covers not only the streets but also bridge territory. Mayor Low requested that separate plans be submitted, which has been done. The Rapid Transit Commission has submitted the whole subject to a sub-committee to ascertain and report at an early date on the third plan. The syndicate interested consists of Stuyvesant Fish, George W. Young, Cornelius Vanderbilt and others.

The Daft and Williams System of Electrical Prospecting for Mineral Ores.

Messrs. Leo Daft and Alfred Williams for the past several years have collaborated in working on the problem of locating bodies of metallic ore beneath the earth's surface by means of electricity, and a system devised for this purpose has recently had some successful trials in England in prospecting for lead and zinc ores in Wales, and for hematite in Cumberland. Former systems for this purpose have, as a rule, been merely based on tests of the local resistance of the earth by means of constant currents, and too frequently the variations caused by the earth's connections have led to wholly erroneous conclusions.

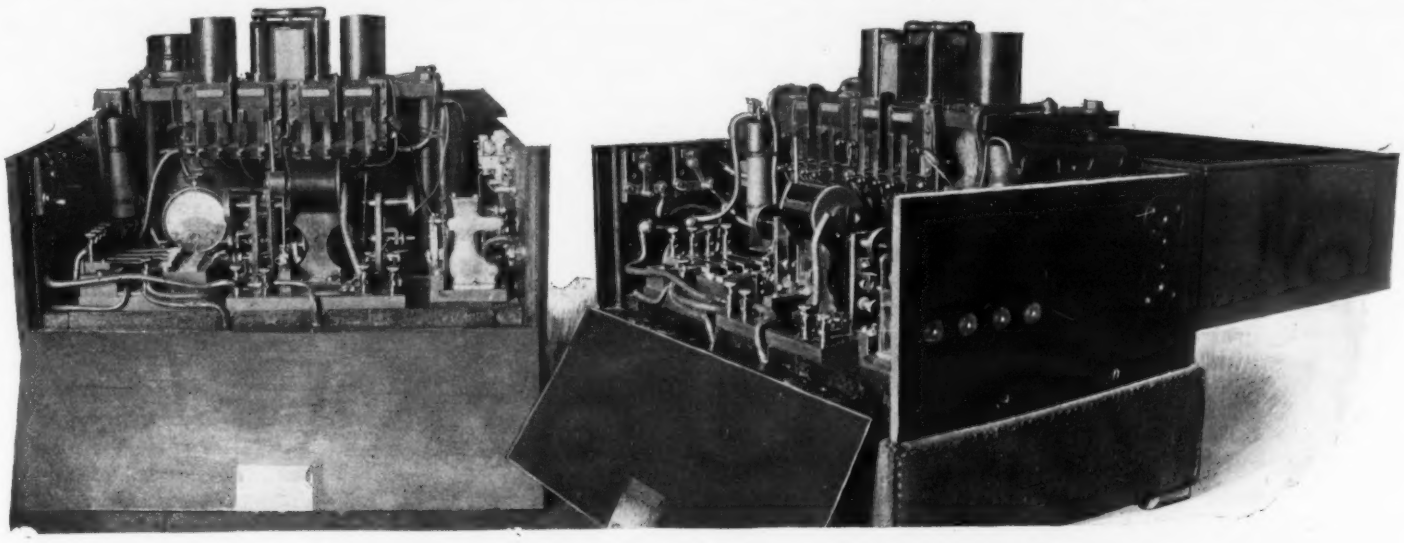
The present system employs the discharge from the secondary of an induction coil to set up an electrical disturbance between two electrodes driven into the earth at a considerable distance apart. For instance, in commencing a survey, 200 yards is a common distance between these two electrodes. With, say, 150,000 volts on the secondary of the induction coil, the effect produced as an earth disturbance can be traced quite a mile away from the electrode. The procedure is then as follows: Two other electrodes, with a telephone connected between them, are used to ascertain the direction of the oscillating currents in the surrounding district. If the earth were homogeneous, the lines of maximum effect, with a given distance between the exporing electrodes, would be as laid down by theory. The presence of a vein of ore, or of a pocket of metallic material, causes disturbance in the symmetrical distribution of the current streams, and these can be traced and located.

The engineer of the Ewmystyth mines in Cardeganshire, Wales, reports that by the use of this system he was able to locate a paying lode of lead and blende ore. These mines have been worked for centuries, and a number of good paying lodes were found to cease suddenly in one direction owing to faults in the formation. Costly attempts to discover these lodes beyond the fault have usually been unsuccessful. In the case mentioned, the two electrodes were placed at a considerable distance away from the broken lode, in unmined ground, and in such a position that a perpendicular through the center of the line joining the two electrodes would coincide with the run of the lode as worked out. The current streams from the one electrode to the other would thus, under normal conditions of homogeneity, pass at right angles through the extension of the lode if it existed beyond the fault. Exploring with the telephone, as explained above, it was found that on the hillside the line of normal current flow was in several places rotated through a very considerable angle. After careful mapping out of the results obtained, the lode was located, and reached after driving through about three fathoms of rock. The old headings were then found to be receding in a direction which was practically an asymptote to the lode, and hence would not have cut it, although very near to it.

In the ordinary way, when exploring a new field, the telephone gives the note of the induction coil, and the lines of flow are determined by moving one of the exploring electrodes round a circle until this note is loudest. Besides this effect, however, the telephone gives evidence of condenser-like discharges betwen large bodies of ore more or less insulated by the surrounding strata. These condenser discharges can be heard when the distance from the induction coil electrodes is so great that the ordinary note is not heard, and they form a great assistance in prospecting. The influence of water in the ground is not such as to prevent the method being employed, and in practically all cases it has been worked in what might be termed water logged strata.

The apparatus used, shown in Figs. 1 and 2, are, with the exception of the induction coil, exceedingly simple in character, and can be moved about by a few able-bodied laborers. The induction coil is especially arranged for the purpose, and has provision made for inserting condensers either in series or parallel with the electrodes. The condensers, which are used at both transmitting and receiving ends, are designed so that their capacity can be rapidly adjusted. As a rule, the current required is obtained from storage batteries, and the number of watts used in the primary of the induction coil may be as high as 120.

The illustrations show the series-parallel switches, adjustable spark-gap, ammeter, primary circuit-breaks, cut-outs (both fusible and magnetic) and the usual primary adjustable condenser in addition to secondary condensers, which latter are made of "cristoleum" immersed in oil. The poles of the U-core project at the top and a pivoted laminated armature enables the operator to vary the reluctances as required, this latter feature being brought into play when the instrument is used as a simple ratio transformer with the primary condenser cut-out. With the latter cut in for secondary static effects, the air-gap is, of course, left open. The primary break shown is only auxiliary, an independent break of high efficiency being also used. While a considerable energy is used in preliminary surveys, the final determinations are usually made with small quantity, so that delicate differences can be appreciated in the telephone. With the latter forms of apparatus the trembler break of the induction coil is replaced by a motor-driven interrupter designed by Mr. Leo Daft, in which the current is interrupted between two contacts under methylated spirits.



FIGS. 1 AND 2.—APPARATUS FOR ELECTRICAL PROSPECTING FOR MINERAL ORES.

It is stated that the system is singularly accurate in defining the outlines of mineral deposits of what might be called the grosser kind, such as galena, copper pyrites, zinc blende, calamine, nearly all the stannous ores, and even hematite, as established from tests in Wales, Cumberland and Northumberland. With quartz reef gold and similar deposits, the personal equation enters largely into the case, as might be expected.

A Long Electric Road.

The Milwaukee & Southern Railway Company has filed articles of incorporation with the Secretary of State of Wisconsin, its purpose being to construct and operate a railway from Milwaukee to East St. Louis. The motive power is not specified in the articles, but it is understood that an electric line is proposed. The company is capitalized at $50,000.

General Meeting of the American Electrochemical Society.

THE third general meeting of the American Electrochemical Society, held at New York April 16 to 18, was an unqualified success from a social as well as from a scientific and engineering point of view. In every respect it brought out the correctness of Dr. J. W. Richards' closing remarks in his presidential address: "Does not each of us go away from these meetings feeling that he has been sharing in the views of all his electrochemical brothers, and with his mind so filled with suggestions, thoughts and ideas of what may, can and will be done in the near future, that he wishes he had a dozen lifetimes at his command in order to work out to realization this plentitude of ideas? Such is the zeal and ardor which our meetings engender in a high degree, from listening to papers and discussions, by conversations, by simple hand-shakes and seeing our friends, and by breathing the invigorating atmosphere of our assemblies."

It will be remembered that the American Electrochemical Society just enters the second year of its life. The New York meeting was, therefore, the second annual business meeting. From the reports presented by the secretary and by the treasurer, it appears that the society is well situated financially in spite of the comparatively low membership fee, and that the membership is steadily increasing, the number being 492 at present, and applications now on file to be acted upon at the next meeting of the board of directors will increase this by another score.

The election of officers did not change the present constitution of the board of directors. Dr. J. W. Richards was re-elected president, Mr. C. J. Reed secretary, Mr. P. G. Salom treasurer; Dr. W. D. Bancroft, Dr. C. A. Doremus and Dr. W. R. Whitney vice-presidents, and Col. S. Reber, Dr. S. T. Sadtler and Mr. C. O. Mailloux managers.

That the good work of the society is recognized by non-members, was evident in different ways, notably from the generous offer made by Mr. A. B. Frenzel, of Denver, Colorado, who proposed the award of $250 for the best paper on the treatment of rare metals, such as molybdenum, varadium, thorium, tungsten, etc. Mr. Frenzel, whose offer was accepted by the board of directors, will supply engineers who intend to take up this problem, with any reasonable amount of ore necessary for the investigation. The award of the prize will be made by the board of directors of the society.

Among the foreign guests of the society at the meeting were Dr. Walther Nernst, the distinguished professor of electrochemistry at the University of Göttingen, Germany, and inventor of the Nernst lamp; Dr. Bussmann, director of the Nernst lamp department of the Allgemeine Electricitäts Gesellschaft, of Berlin, Germany, and Dr. Reisnegger, of Auzsburg, Germany, as representative of the well-known firm of Meister, Lucius & Bruning.

The last edition of the printed list of members and guests who registered at the meeting showed 193 present, but subsequently the number of registered members and guests increased to somewhat over 250.

For the afternoons of April 17 and 18 various visits had been arranged, and the number of places visited including the Sawyer-Man Electric Company, a special exhibit of electrochemical apparatus by Eimer & Amend, the laboratories of Cooper Union, the Willyoung & Gibson Company, the Crocker-Wheeler Electric Works, a galvanizing plant installed at the Brooklyn Navy Yard by the United States Electro-Galvanizing Company, the Edison station at Thirty-eighth Street, the Manhattan Railway Company's power house at Seventy-fourth Street, the Metropolitan Street Railway Company's power house at Ninety-sixth Street, the new Rapid Transit Tunnel at Fifty-ninth Street and Broadway, Columbia College and the New Jersey Zinc Works.

On the evening of April 16 a subscription banquet was held in the hall of the German Liederkranz Society, which was handsomely decorated for the occasioin. It was well attended and an extremely enjoyable affair. Dr. C. A. Doremus acted as toastmaster and the following toasts were responded to: "America, the Electrochemical Center of the World," by Dr. J. W. Richards; "Development of Electrochemical Theories," by Dr. Walther Nernst; "The American Institute of Electrical Engineers," by Mr. C. F. Scott, President of the Institute; "The American Chemical Society," by Dr. C. F. Chandler, of Columbia University, and "Kitchen Chemistry," by Dr. H. W. Wiley, of the United States Department of Agriculture.

On the evening of April 17, the society was the guest of the American Institute of Electrical Engineers, at a meeting held in the College of the City of New York. Over the entrance of the building electric lamps showed the initials, "A. I. E. E." and "A. E. S." An account of this meeting will be found elsewhere in this issue. On the evening of April 18, after the presidential address of Dr. Richards, Mr. Thomas exhibited the Cooper Hewitt rectifier and Dr. M. von Recklinghausen lectured on the mercury vapor lamp. Afterwards an extremely enjoyable German-American "smoker" ended this highly successful convention.

The scientific and engineering value of the convention must be judged from the papers and discussions, a concise but complete report of which follows. All the meetings were held in the large assembly hall of the Chemists' Club.

CONSTANT-VOLTAGE AND CONSTANT-CURRENT SEPARATIONS.

Dr. W. D. Bancroft, of Cornell, pointed out in this paper a general rule of classification for the numerous methods given in text-books on electro-analysis. He called attention to the fact that there are used in practice two essentially different methods for separating metals from other metals; according to one method it is the voltage which is kept constant, while by the other it is the current. The object of Dr. Bancroft's paper was to show why in each case the one or the other method is to be used.

Since the electrolytic separation of two metals depends on the fact that one precipitates at a lower voltage than the other, it would seem as though the proper way to effect a separation is to hold the voltage at a value such that the second metal cannot precipitate. This method has the advantage that the current drops to a very low value as soon as the first metal is completely precipitated, thus giving an automatic indication of the degree of precipitation. As a matter of fact, however, this constant-voltage method is not used in most of the standard separations, which are rather to be classed as constant-current separations, even though the current may not be held absolutely constant. If in such a constant-current method the second metal contained in the solution be prevented from being separated, it is of course necessary that at the end of the separation when the solution gets poor in the first metal, something else is deposited from the solution together with the first metal instead of the second metal; this "something else," which should not change the results, is in practice, hydrogen. The essential supposition, therefore, under which a constant-current separation becomes possible is that the decomposition voltage for hydrogen in the solution used shall lie below the decomposition voltage of one of the two metals. Since most separations were originally made without a voltmeter in circuit, no satisfactory results were obtained until a solution was found which permitted of a constant-current separation, and for this reason all except some of the most recent separations are constant-current separations.

The order in which the different metals and hydrogen are deposited from a solution with increasing voltage, is, therefore, of the greatest importance. Dr. Bancroft gave tables showing the order of the metals deposited from solutions of sulphates or chlorides, cyanides, oxalates, phosphates and tartrates. In another set of tables he gave a summary of the majority of the separations for silver, mercury, copper, bismuth, tin, lead, nickel, iron, cadmium and zinc. If hydrogen is evolved before the second metal, the constant-current method is feasible and is used in practice; otherwise constant voltage must be used. From Dr. Bancroft's tables it appears that this rule is generally correct (with a few exceptions which are explained in the paper) and that the overwhelming majority of the usual electro-analytic separations can be run at constant current without reference to the voltage. Some special points of Dr. Bancroft's paper were discussed by Messrs. Keith, Bigelow, Hering, Reed and Carhart.

EXPERIMENTAL STUDY OF SOME ELECTRODE EFFECTS.

In the absence of the author, Dr. H. T. Barnes, of Montreal, this paper was read by Dr. Bancroft. The author points out that in electrolytic experiments two apparently equal platinum electrodes never behave alike; the same is the case with other metals. The disturbing factor appears to be the air, which is dissolved in the solution, and the presence of air dissolved in the solution seems to be of greater importance even than any air dissolved in the elec-

trodes. Various experimental facts are quoted in support of this view. The paper was not discussed.

THE ELECTROLYSIS OF WATER.

Dr. J. W. Richards and Mr. W. S. Landis gave in this paper the results of a rather extended series of experiments. One of their most interesting experiments was made with a closed vessel, compltely filled with the electrolyte. A very thick, strong thermometer tube was used, filled with dilute sulphuric acid, which had been carefully boiled before in order to get rid of the gases. The ends through which the platinum wire electrodes were introduced were carefully sealed. Although an e.m.f. of 3.3 volts was applied, no current whatever was found to pass through the solution, but as soon as the seal was broken the current passed.

The authors then described several experiments made to test Thomson's rule. In one the e.m.f. and current were carefully measured and at the same time the Joulean heat was determined by the rise of temperature, measured with a thermometer. From these data the decomposition voltage was found to be 1.49, in accordance with Thomson's rule. In another set of experiments the cathode was observed by a microscope in order to detect the formation of gas bubbles, while the voltage was gradually raised in steps of 0.05 volt. At 1.45 volt no gas bubbles could be detected, while they appeared at 1.5 volt.

The authors finally investigated the so-called residuary current (Reststrom). Current passes with any applied voltage below the proper decomposition e.m.f., the amount of the current increasing with the voltage. The concentration of the sulphuric acid used makes very little difference, but the amount of the current depends largely upon the quantity of the gases dissolved in the electrolyte. The limit is reached when these gases (which act like depolarizers) are used up; then the proper residual current sets in. The authors further made experiments with the electrodes 8¾ meters apart, and in another case a small fraction of a millimeter apart; in the first case there was absolute conformity with Ohm's law, but not in the latter case.

The paper was discussed at length by Messrs. MacNutt, Hering, Reed, Bigelow, Cowles, Bancroft and Burgess. Mr. Hering doubted the suitability of platinum electrodes for such experiments and would have preferred gold electrodes. Mr. Reed referred to some old experiments of Faraday from which he concluded that above a certain voltage there is electrochemical decomposition, while below this voltage there is metallic conduction. Prof. Burgess gave an account of experiments made by him on the influence of the pressure on the e.m.f. Dr. Bancroft doubted if the experiments of the authors were exact enough to say that Thomson's rule is strictly correct, and added that we have absolute evidence that it is not exact.

EXPERIMENTS WITH METALLIC DIAPHRAGMS.

In this paper Dr. Bancroft describes some experiments in which metallic plates were interposed between the anode and the cathode in a solution. In this case one can have anything between the two extremes, if all, or practically all, of the current passing through the diaphragm and practically none of the current passing. When the diaphragm fills the cross-section completely, all the current must pass through it, and in order to pass a current, an excess voltage, is necessary due to polarization, if the diaphragm does not behave as an absolutely reversible electrode. If the diaphragm does not divide the electrolyte into two detached compartments, no current will flow through it, unless it requires a smaller expenditure of energy than to make the current flow through the electrolyte. Since the resistance of a metal plate is practically always less than the resistance of an equal thickness of electrolyte, current will always pass through an interposed plate unless prevented by polarization. If the thickness of the interposed plate be sufficiently great, the fall of potential in the plate plus the polarization may be made less than the fall of potential in the liquid, and current will then pass through the diaphragm. He experimented with a thick carbon plate interposed between anode and cathode in a copper sulphate solution, in order to find the exact conditions under which there is precipitation of copper on the side facing the anode. When the fall of potential between the ends of the carbon plate, as measured on copper wires dipped in the electrolyte, is less than one volt, there is no precipitation of copper. When the fall of potential exceeds 1.4 volt, there is a rapid precipitation of copper on the end of the carbon plate nearest the copper anode. On passing a current for a long time, there was a slight deposit of copper even when the difference of potential was only 1.1 volts, i. e., below the decomposition value. He then experimented with platinum, and in order to avoid plates of great thickness, he used two movable platinum electrodes connected metallically outside the solution; he had expected that this would be equivalent to a massive platinum bar, but this proved not to be the case. Instead of one electrode being anode and the other cathode, each electrode behaved to a certain extent both as anode and as cathode. The paper was not discussed.

THE PROTECTIVE ACTION OF ZINC CHLORIDE ON METALLIC IRON.

In this paper Mr. C. J. Reed related some facts which he thinks are not in agreement with the dissociation theory. It is now generally recognized that the rusting or oxidation of metallic iron in the presence of water and saline solutions is an electrochemical process, the water or saline solution being the electrolyte and the metallic iron the anode. Small particles of garphitic carbon and other impurities or alloys serve as cathode to form local voltaic circuits. According to the dissociation theory this attack of iron in a chloride solution would be due to the chlorine ions and should take place in a zinc chloride solution in the same manner as in a sodium chloride solution. He found that iron nails placed in a zinc chloride solution did not rust in any case; in strong zinc chloride solutions which had been boiled with metallic zinc and contained no free acid, there was not the slightest action of any kind upon the iron. This paper was the last read at the morning session of April 16. The first paper of the afternoon session dealt with

INSULATING MATERIALS, A FIELD FOR CHEMISTS.

The author, Dr. M. von Recklinghausen, pointed out that chemists are indebted to electrical engineers for the great advantages of the use of electric power and should show their gratitude by studying the problem of devising an electrical insulating material which is good all around. Chemists sometimes offer materials for insulation which may have *one* good property; for instance, may have enormous resistance to the passage of a current, but may be so highly inflammable or may have such a low melting point as to be utterly useless for the purpose intended. The author gave a systematic review of the desirable and undesirable qualities of the prominent insulating materials used nowadays; the desiderata are good insulation resistance, high disruptive strength, and good mechanical properties, especially workability; faults are combustibility, a low melting point, and changes of the electric and mechanical properties, with rise of temperature or with age, and, of course, high price. He briefly reviews the different materials which come into consideration. Of liquid organic compounds oils are the most important; their disadvantage is their combustibility. It has been proposed to use halozen carbon compounds, instead of hydrocarbon compounds. Among the organic compounds used in a solid and more or less plastic state there are varnishes, lacquers, drying oils, rubber, cellulose materials, etc. Most of them have very undesirable qualities. The pure cellulose compounds are probably very good in most respects, and seem to be less affected by heat and less inflammable than other materials of this group; but up to now they are fairly difficult to get into the desired dense mechanical shape. Mixtures of asbestos or mica with varnishes, rubber or similar materials mostly lack flexibility and mechanical strength. Inorganic solid materials, like slate, marble, asbestos, porcelain and glass, lack flexibility. Progress is probable in the line of cements that can be molded, although up to now they seem to be too hygroscopic. A tremendous step forwards would be a material of the flexibility of asbestos and the ideal high insulating and dielectric strength of mica. The paper was not discussed.

A HISTORICAL REVIEW OF THE STORAGE BATTERY.

A paper on this subject was read by Mr. H. B. Coho. As it was a review of the development of the storage battery industry, with brief and concise references to its various phases, it is impossible to give a brief abstract of the paper. In the discussion which followed, Dr. H. S. Carhart related that in 1881 Planté told him he had tried to apply by mechanical means the active material on the plates, but had found such plates did not give as good results as plates formed electrochemically.

THE USE OF PYROXYLINE IN ELECTRIC STORAGE BATTERIES.

A paper on this subject was presented by Mr. Elmer A. Sperry. After some general remarks on the inherent weakness of the positive plates of the lead storage cell, he discussed the use of a pyroxyline envelope which is wound around the plate, passing down one side,

under the bottom of the plate and up the other side. If any active material should be loosened accidentally, it is thus prevented from dropping off, being held in its position by the pyroxyline envelope. This cover is made of open-mesh cotton cloth, such as cheese-cloth, which is chemically treated, forming a cellulose nitrate, termed "pyroxyline," of the same general character as gun cotton. Batteries with pyroxyline envelopes have been in continual use for three years and proven entirely satisfactory. The initial difficulties which were evperienced in the manufacture of the pyroxyline envelope have been entirely overcome. The paper was briefly discussed by Mr. C. J. Reed. Mr. Sperry remarked that the pyroxyline cannot be used on the negative plate.

THE CONCENTRATION CHANGES IN THE ELECTROLYSIS OF BRINE.

In a paper on this subject, Dr. W. H. Walker discussed the results of experiments recently published by C. T. Townsend in *Electrochemical Industry*. Dr. Walker showed that the results observed by Mr. Townsend can be simply explained by means of the migration of ions, and that the resulting concentration changes can be calculated from Hittorp's transport numbers. At the beginning of the test only the sodium and the chlorine ions travel; but afterwards, when sodium hydroxide has been formed, the HO ions participate in the conduction of the current, and for the numerical calculation it is necessary to take them into account. Mr. Townsend stated that he is not at liberty at present to discuss the whole matter freely, but will do so in future.

THERMO E.M.F. WITHOUT DIFFERENCE OF TEMPERATURE.

In this paper Prof. H. S. Carhart presented a very clear and simple thermodynamical theory of concentration cells and of galvanic cells in general. The Peltier effect is a single example of a very general law; if a current passes through a junction, energy is either given to the circuit or taken from it. The flow of the current produces a difference of temperature. These temperature changes have nothing whatever to do with the Joulean heat. Prof. Carhart pointed out the essential difference in the behavior of a circuit, consisting of metals only, and of a circuit consisting of both metals and electrolytes. He then showed how the Carnot-Clausius thermodynamical cycle can be applied to the theory of a galvanic cell.

THE CORROSION OF METALS BY ELECTROLYSIS.

A long paper on this subject was read by Mr. A. A. Knudson, a portion of which is reprinted elsewhere in this issue. He first took up the subject of electric currents generated in the earth by local circuits formed by different metals in contact with another and with the damp earth acting as electrolyte. An analogous case is the corrosion which often takes place in vessels, due to galvanic action. If, when repairs become necessary, iron patches are bolted over the copper-plated hull of a vessel, corrosion is bound to follow. A still more important case of sea water corrosion due to placing together dissimilar metals, is sometimes found on the propeller shafts of steamers. The author then discussed the electrolytic action of the return currents of electric railways upon gas and water pipes, as well as upon metallic structures, such as bridges, which portion of the paper will be found elsewhere.

The paper was discussed at some length by Mr. Carl Hering, who pointed out that the corrosive effect on pipes depends upon the current flowing in them, and that in very many cases it is absolutely wrong to judge from voltmeter measurements what this current may be. He suggests to measure the current in a pipe as follows: Connect two points of the pipe selected with an ammeter as well as with a voltmeter and take a reading of the ammeter and of the voltmeter; disconnect the ammeter and take another reading of the voltmeter; then the current in the pipe is given by a very simple formula, which may be easily found by using Ohm's law. Mr. Hering suggested to apply the following remedy at such points of iron pipes where electric currents are tending to leave them and thus to destroy them by corrosion. Connect at such places the iron pipes with a block or plate of zinc; then the currents will not pass from the iron directly into the earth, but first into the zinc and the corrosion of the iron is thus prevented; the zinc is of course gradually eaten up. It may pay to prevent the corrosion of iron docks in the same way, by connecting them with a block of zinc. Mr. C. J. Reed mentioned that the same remedy of the use of zinc is being applied and has proven very satisfactory on steamships to prevent the destruction of condenser tubes.

The first paper of the session on April 17 was entitled—

NOTE ON THE COMPOSITION OF ELECTROPLATING SOLUTIONS.

The author, Dr. N. S. Keith, said that in electroplating and electrotyping the anodes should be of the pure metals; otherwise if the impurities be metals electropositive to that which is transferred, they will either enter the electrolyte, thus changing its constitution by the introduction of undesirable salts; or they may, if insoluble, form crusts on the anode, consisting of insoluble and non-conductive salts. The ideal electrolyte wherein metal is to be transferred is a solution of that metal which has no corroding effect on either the anode or the cathode when no current is flowing through the cell. Such a solution may possibly be made; but in operation, when current passes, it can be maintained only with difficulty. The author suggests the use of strong solutions with abundant solvent of the salt formed at the anode and rapid circulation; under such conditions high current densities may be used and deposits are rapidly obtained. The author discusses especially gold and silver plating and finally refers to his process of refining lead base-bullion, separating its contents of gold and silver by electrolysis. The general tendency in electroplating solutions in operation is to form oxy salts at the anode. This is undesirable and, if avoided, either by suitably composing the solution, or by properly operating it, the best results will be attained.

In the discussion which followed Mr. H. E. Heath spoke on the use of unipolar machines for electroplating. Mr. C. O. Mailloux then gave an extended and very interesting account of experiments made by him some years ago in the electroplating line; he pictured the metal inertia of the average electroplates. He described how he had developed a plating process by careful and systematic laboratory work and how it became an easy matter to get very good deposits with a current density of 500 amp. per square foot, thus shortening the time of the process very considerably. The paper was also discussed by Messrs. Eddy, Reed, Johnson and Hering.

DETERMINATION OF VAPOR DENSITIES IN THE ELECTRIC FURNACE.

A highly interesting paper on this subject was read by Dr. Walther Nernst, of the University of Göttingen, Germany. The method employed is the classic one of Victor Meyer, which heretofore could not be used at temperatures higher than about 1800° C. It is now possible to use the same method for temperatures of about 2000°, by using apparatus of iridium, which has a melting point of somewhat over 2200°. Heræus of Hanau succeeded in making a small but expensive apparatus. The reading is taken by measuring the motion of a mercury meniscus. Small egg-shaped vessels of iridium are used to contain the substance and the weighings are made on a specially devised torsion balance. From some examples, quoted by Dr. Nernst, it appears that the method is surprisingly accurate. The author's achievement was highly commended in the discussion by Messrs. Bancroft, Backeland and Richards.

NOTE ON ELECTRICAL ENDOSMOSE.

A brief paper was then read by Dr. W. D. Bancroft on electrical endosmose or cataphoresis. The author pointed out the great importance of this phenomenon for scientific as well as technical work. It should not be neglected, as is generally done; it may in some cases be even more important than the effect of the true migration velocities of the ions. It is of importance to know that it is possible by proper choice of the diaphragm to obtain the degree of endosmosis wanted for the special purpose. The paper was not discussed.

IONS AND ELECTRONS.

Dr. Louis A. Parsons, of Johns Hopkins, read a paper in which he gave a review of the work of various investigators, especially J. J. Thomson, which led to the modern conception of electrons, and discussed the relation between electrons and ions. As the first part of the paper was a concise summary of the historical development of the electron theory, and as the second part was highly mathematical, it is impossible to give a brief abstract of the paper. It was not discussed.

UNIFORMITY IN ELECTROCHEMICAL EQUIVALENTS.

A brief paper on this subject was read by Mr. Carl Hering, who suggested that, for the sake of uniformity, electrochemists should adopt a combination of certain values already adopted by authoritative bodies. They are the electrochemical equivalent of silver 0.001118 gramme per conlomb, and the table of atomic weights issued by the American Chemical Society. This leads to a change of a unimlent grain ion of 96,538.5 conlombs, or approximately 96,540 conlombs, which is already widely in use. The paper was discussed

by Messrs. Bancroft, Cowles and Richards. Dr. Bancroft remarked that from recent measurements of T. W. Richards it seems that 96,600 conlombs is more correct than 96,540.

E.M.F. OF ALLOYS.

A brief note on this subject was then presented by Dr. W. D. Bancroft on the e.m.f. of alloys with respect to one of the two metals. He pointed out an apparent anomaly and explained it by showing that it was due to the fact that in such abnormal cases there is no chemical equilibrium. The paper was not discussed. This was the last paper read at the Friday session.

ELECTROLYTIC PRODUCTION OF METALLIC COMPOUNDS.

A long paper by Prof. C. F. Burgess and Mr. Carl Hambüshen, of the University of Wisconsin, was then read by Prof. Burgess. The authors point out the limitation of the methods at present available and deal with some of the difficulties which must be encountered in large scale working. The suitable design of electrolytic apparatus requires special ingenuity and skill of the designer. The advantages of electrochemical methods over purely chemical methods are pointed out in various special cases. The authors then give an account of an extended series of experiments in which they tested various processes for the production of white lead; they reach the conclusion that there is little chance for the electrolytic process replacing the chemical methods at present. In the production of various other lead compounds, however, there seems to be greater opportunity for commercial application of the electrolytic method, and lead acetate, lead chloride and lead chromate may be produced to advantage by electrolytic methods.

Officers and Guests of the American Electrochemical Society.
(Photographs taken by Cooper Hewitt Light—Three Seconds' Exposure.)

THE ELECTRO-DEPOSITION OF METALS UPON A ROTATING CATHODE.

A paper on this subject by J. G. Zimmerman was read by Prof. Burgess. The result of the investigation is that the use of high-current densities in depositing metals is made possible by the use of rapidly rotating cathodes. The critical current density, i. e., that at which a powdery deposit occurs, is approximately proportional to the speed of rotation. In the case of nickel plating, particularly, this method has great advantages, as it is possible to obtain a much thicker coating of nickel when the cathode is rotated than when stationary. Zinc behaves quite differently from nickel. Increase of current density by means of rotating cathodes is also possible in the case of iron, lead, antimony and silver. The paper was discussed at some length by Messrs. Burgess, Hering, Eddy, Bancroft, Heath and Mott. Mr. Hering suggested that a strong circulation of the electrolyte would have the same effect as rotating the cathode.

ELECTROLYTIC CONDUCTION WITHOUT ELECTRODES.

A paper on this subject was read by Mr. A. B. Marvin. He described several arrangements based upon the principles of dynamo construction and designed to detect electrolytic conduction without any electrodes. The best results were obtained with an apparatus consisting essentially of two alternating-current transformers of somewhat peculiar construction. The primary of the first was excited from a 125-cycle alternating-current power circuit. Its secondary winding, which consisted of a tube of electrolyte, served also as the primary of the second transformer, and the secondary of this second transformer was connected to a telephone receiver. Thus the impulses induced in the core of the first transformer were transmitted through the electrolyte to the core of the second and thence to the telephone. Whether decomposition of the electrolyte takes place is not definitely determined, but probably it does not.

POTENTIALS OF ZINC IN AQUEOUS SOLUTIONS.

A joint paper by Dr. H. E. Tatten and Mr. W. R. Mott, illustrated by a great many diagrams, was read by Mr. Mott. The first part of the paper dealt with single potentials of zinc in various aqueous solutions and one conclusion reached by the authors is that the so-called solution tension of zinc seems to be a "rather elastic quantity." The second part of the paper deals with decomposition points and various methods are discussed.

NOTES ON THE ELECTRO-DEPOSITION OF NICKEL.

A paper on this subject was read by Mr. Woolsey McA. Johnson. The author gives in this paper some extensions of his notes given in a recent number of *Electrochemical Industry*. He discusses at some length the reasons why hot solutions are used in processes. It is quite possible to obtain good deposits from cold solutions, but for certain commercial reasons which are explained by the author, the use of a hot solution is advantageous. In the second part of his paper the author discusses why the use of a hot electrolyte prevents the curling of nickel deposited at high-current density. He suggests that this fact is directly connected with the formation of nickel-hydrogen alloys.

NOTES ON MODERN ELECTROLYTIC COPPER REFINING.

A paper on this subject by Mr. Titus Ulke was read, in the absence of the author, by Dr. J. W. Richards. Mr. Ulke suggests that the managers of copper refineries might profitably adopt the methods of the American iron and steel makers and allow engineers free access to all parts of their plants and thereby encourage a free exchange of ideas and the obtaining of mutual benefits. All the so-called mysteries of electrolytic copper refining may be resolved into certain more or less well-known simple rules of practice. The material at present subjected to profitable electrolytic treatment in electrolytic refineries is invariably a precious metal bearing crude copper cast into anodes, assaying at least 96 per cent. copper and generally refined by fire methods up to 98 or 99 per cent. The initial cathode sheets are invariably thin sheets of electrolytic copper, obtained by deposition upon and stripping from greased, oiled plates of copper or lead. The constantly decreasing acidity and the constantly increasing copper contents of the electrolyte must be maintained within certain limits. Heating the electrolyte up to 40° or 50° C. is advantageous. The author enumerates the various improvements in details made in recent years in American copper refineries. He also gives some statistical data.

NEW APPARATUS.

Mr. A. Eimer exhibited and explained some improved electrochemical apparatus, especially several new forms of electric furnaces.

Two papers, by Mr. P. G. Salom and by Mr. A. H. Cowles, were

withdrawn and will be presented at the next meeting. The papers by Dr. J. W. Walker on the influence of some impurities in salt upon the yield of soda by the amalgam process, and Dr. C. W. Volney on the formation of nitric acid under electric influences, were read in title in the absence of the authors.

CONDITIONS OF PROGRESS IN ELECTROCHEMISTRY.

The presidential address of Dr. J. W. Richards dealt with this subject. The speaker discussed the subject under the following headings: Discovery of new facts; better understanding of the laws of co-relating facts; more rational theories of the why and wherefore; increasing application of the facts to the welfare of mankind; increasing dissemination of scientific literature, and an increasing vision on the part of the scientist of the possibilities of scientific achievement. The address was received with much applause.

After the presidential address, Mr. Thomas made an excellent presentation of the new Cooper Hewitt static converter described recently in these pages, and showed it in operation transforming three-phase current into direct to run lamps, motor, etc. After this Dr. Recklinghausen made a demonstration of the Hewitt mercury vapor lamp with special regard to its actinic qualities. As an illustration of its use in photography, ELECTRICAL WORLD AND ENGINEER then took some photographs. Those shown on page 697 were of 3 seconds' exposure. Others of 8 and 10 seconds were decidedly over-exposed and have not been reproduced here, although in some of them the individual likenesses are superb. The evening closed with a Kneipe given by the Chemists' Club and participated in by about 200 persons.

Lecture of Mr. W. J. Hammer.

On Friday evening Mr. William J. Hammer delivered at the College of the City of New York a lecture before a joint meeting of the American Institute of Electrical Engineers and the American Electrochemical Society, the title being "Radium and Other Radio-Active Substances, with a Consideration of Phosphorescent and Fluorescent Substances; the Properties and Application of Selenium, and the Treatment of Disease by Ultra-Violet Light." The attendance was very large and the greatest of interest was shown in the numerous experiments which Mr. Hammer had devised for the occasion. Since the lecture as issued in printed form by the Institute would cover, with the cuts, about 16 of these pages, only a brief summary of it can here be given.

In opening the meeting, President Scott referred to the American Electrochemical Society as indicating by its name the intimate connection between two branches of sciences and of industry. Electricity and chemistry in many of their aspects may have little in common; but the mystery of electricity and the secret of chemical affinity are not far apart. There is an overlapping field in which there is a new science, a new industry and a new society. He contrasted the slow development of the dynamo, reaching over the span of a lifetime, with the recent development following the announcement of the discovery of Prof. Röntgen. Immediately in laboratories all over the world extended experiments and investigations were begun, apparatus was forthcoming for practical use and within a twelvemonth the Röntgen ray was an important adjunct in many a hospital. This difference is due to a change in the method of doing things, in the method of scientific observation and of scientific generalization on the one hand, and in the facility of the inventor and the engineer to develop and utilize the new material which is put at their disposal. To this must be added as a factor in modern development the attitude of the general public. The scientific observer and the inventor are no longer wizards to be shunned or executed. Science and engineering have done so much in the past that there has come to be a wonderful faith in the future.

On the one hand we marvel at the advance which has been made in science, invention and engineering. On the other hand, we find that in every direction we have only entered upon the fields of nature, which lies before us promising and unexplored. In the production of light and mechanical energy, for example, we are wonderfully in advance of our forefathers, but our present methods are crude and inefficient compared with what we know to be theoretically possible in the transformation of energy if we had but the means. It is, therefore, with a peculiar interest when attention is directed to an unfamiliar subject; that we learn of the wonderful properties of a rare element; and that we direct our thoughts to a new field laden with great possibilities.

Mr. Hammer opened his lecture by describing the Finsen method for the treatment of disease by ultra-violet rays. His remarks were illustrated by views projected on a screen, of the apparatus employed by Dr. Finsen, and of portraits of patients before and after treatment, showing the marvelous curative effect of ultra-violet rays in cases of lupus.

Next taking up the subject of selenium, Mr. Hammer, after giving a historical résumé, conducted a number of interesting experiments. He described the method of making selenium cells, and showed quite a number of different types. He also explained various methods in which selenium has been employed in talking over a beam of light and in wireless telephony, and the various methods suggested for the use of selenium in seeing at a distance. One of the experiments consisted in the transmission of speech by the aid of the selenium cell. By talking against a pig-skin diaphragm, acetylene gas behind the diaphragm is made to vibrate and produce a manometric flame, the light of which when turned upon a selenium cell connected with a telephone reproduces the sound spoken into the gas transmitter. By means of a selenium cell in connection with a battery and relay, a motor was started, a horn blown, a bell rung, a cannon fired, and incandescent lamps lighted, merely by interposing the hand between the selenium cell and a ray of light falling upon it. A 3-hp motor driving a 2-kw generator supplying a bank of lamps was easily started and stopped in the manner described.

Referring to a suggestion that safes could be burglarized by electrical means, Mr. Hammer suggested placing a selenium cell in or

APPARATUS USED FOR ILLUSTRATING LECTURE.

near the safe so that the moment light was produced by the electrical or other means employed, an alarm would be sounded; he referred to the probable use of thermite in burglary, this consisting of an oxide of iron mixed with powdered aluminum, which gives rise to an extremely high temperature if magnesium be placed on the top and touched off by a match. He spoke of the use of selenium cells on buoys, by means of which the gas for lighting is turned on automatically at the approach of darkness, and vice versa. He also described the Ruhmer photo-graphophone, views of which were projected on a screen. A gelatin film driven at a high speed is subjected to the action of an electric arc, in the circuit of which is a telephone. Words spoken or sung into the telephone superimpose the telephone waves upon the current flowing in the arc, and cause a corresponding variation in the light of the arc, which affects the photographic film. The film may then be passed at the previous rate between an arc lamp and a selenium cell, whereupon a telephone in the circuit of the latter will reproduce the original sound. Numerous other applications of selenium were described. The cost of the material is said to be $1 per gramme for pure crystalized selenium, the ordinary commercial article costing about 10 cents per gramme.

Mr. Hammer then took up the subjects of fluorescence and phosphorescence, which were illustrated by a large number of experiments, many of which were striking in their effects. The subject

led to the consideration of cathode rays and Röntgen rays. In this portion of the lecture Mr. Hammer illustrated an interesting and important discovery which he has made, namely, the production of cathode rays from Röntgen rays, thus reversing the Röntgen ray cycle. By bombarding the outer surface of an Edison Röntgen ray tube, he caused cathode rays to pass within the tube. This was indicated by the tungstate of calcium within the tube becoming brightly phosphorescent, and the fact that the stream could be deflected by a magnet.

A considerable portion of the lecture was devoted to radium, which opened with a historical account of its discovery and of the investigations of its radio-active properties, together with a sketch of its relations with other mineral deposits. He also referred to the properties of various other substances related to radium, such as uranium, actinium, polonium and thorium. Referring to the cost of radium, he gave the figure $2,721,555 per pound as the market rate for the purest grade now obtainable; such a quantity, however, is not in existence, and the material thus far experimented with has been in extremely small quantities.

Mr. Hammer pointed out that polonium and uranium do not possess the power of exciting radio-activity, whereas there is an actual emanation from radium and thorium, which produce radio-activity in surrounding objects. He referred to the discrepancy between a statement of Heydweiller and statements of Becquerel, J. J. Thomson and others concerning the loss of weight of radium. The latter authorities have stated that there is no perceptible loss of weight, and this the former has contradicted. Mr. Hammer says that since Heydweiller printed his denial it has been found that an error during his experiments invalidated his results, and that later experiments he has undertaken point to the correctness of the accepted position of Thomson and others. He said that it is noteworthy that radium rays induce activity which persist, whereas that excited by Röntgen rays ceases immediately on the removal of the rays. He showed an interesting original experiment in which radio-activity imparted to cardboard and tin had been restimulated after it had become too faint to be appreciable to the eye, by burning magnesium wire before the object or exposing it to ultra-violet rays. Mr. Hammer projected on the screen a number of photographs which he has taken of objects by means of radium, which illustrated the penetrative character of the radium rays, the effect of a magnetic field upon certain of the rays, the Röntgen ray characteristics present, etc. Among other things, he showed a radium radiograph of a human hand. The account which Mr. Hammer in his lecture gave of radium and its properties is perhaps the most exhaustive that has yet been printed, and the same is true with respect to selenium. Indeed, the paper is a mine of information on the several subjects which it considers.

CURRENT NEWS AND NOTES.

NEW YORK ELECTRICAL SOCIETY.—The next meeting of the New York Electrical Society will be held at 19 West Forty-fourth Street, New York, April 29 at 8 P. M. Mr. Bion J. Arnold, consulting engineer of the New York Central Railroad, and also of the Chicago City Council, will lecture on "The Rapid Transit Problem in Chicago and Other Great Cities."

LIGHT FOR THE KAISER.—The Kaiser has decided to bring the old palace in Berlin and the new palace in Potsdam up to date as regards modern conveniences, heating and lighting. Hitherto lack of elevators and electric light has been frequently the cause of much discomfort. When the works now in progress are finished the Kaiser's palaces will have all the modern improvements, like a New York flat.

ROTARY CONVERTER CIRCUIT.—A patent issued April 14 to Mr. A. D. Lunt, relates to a means for supplying to the direct-current circuit of a rotary converter a third or neutral conductor. This consists of the application of the Dobrowolski method, but the neutral point instead of being an image on an inductive resistance of the neutral point of the machine, is the neutral point of the secondary of the transformer or transformers supplying the machine. That is to say, in the case of a single-phase converter this neutral point is the middle point of the transformer secondary; and in the case of a three-phase converter the point is the middle point of the combined secondaries of the three transformers.

ELECTRIC CURE OF CANCER.—Dispatches from Vienna say that the news published of the discovery of a new treatment for cancer by means of high-frequency electrical currents has attracted the attention of the Viennese medical and surgical profession, the members of which are always keenly alert for every new idea or fresh development in the science of healing. One of the most prominent clinical surgeons does not consider this latest method as of the first importance. In the course of conversation on the subject he stated that the form of cancer known as epithelioma in the skin had been experimentally treated with Röntgen rays for some little time past in Vienna. It was found that this method had certain beneficial effects in temporarily lessening the malignant swelling. At the same time, however, while the outward manifestation of the malady is alleviated by this treatment, the primary cause remains unaffected, inasmuch as the seat of the disease simply penetrated more deeply into the system.

ELECTRIC FREIGHT IN MASSACHUSETTS.—A bill has just been signed by Governor Bates, of Massachusetts permitting street railroads of the State to carry freight. The Massachusetts Electric Companies, which operates over 800 miles of street railways in the State, will no doubt in time be able to take advantage of this law. As an example of the possibilities in connection with the transportation of freight by street railways, Fall River or any of the large mill cities in which the Massachusetts Electric Companies operates, may be cited. The lines of the system touch all the large mills in these cities and are in a position to handle freight from these mills to Boston or some central point to great advantage at a time when the passenger traffic is light. There are great possibilities in connection with freight transportation by the street railways, but few of the street railway properties are as yet prepared to take advantage of the opportunities. Special plans of this nature have been outlined and attempted for some years past.

U. S. NAVY WIRELESS TELEGRAPHY.—It is stated from Washington that tests to determine the true value of wireless telegraphy as a medium of communication in naval warfare will soon be conducted by the Navy Department off Montauk Point. The exact utility of wireless for a fleet attacking New York City will be demonstrated. The auxiliary cruisers *Prairie* and *Topeka*, both of which have been equipped for wireless experiment work, will take their positions at sea off Montauk Point. At changing distances, invariable weather and with five different types of wireless instruments, they will communicate with each other. Efforts will be made by the land wireless station on Montauk Point to intercept the messages between the warships. The ability of a hostile station, either ashore or on another warship, to intercept, confuse or interpret the messages between warships operating together is the most vital problem in the application of wireless telegraphy to modern naval warfare. Captain Arnold expects to make a thorough exposition of this point.

GERMAN WIRELESS TELEGRAPH APPARATUS.—A special cable dispatch from Berlin states that within a few days the first consignment of portable wireless telegraph carriages will be shipped by the Siemens & Halske Company to Washington, to be employed by the United States Signal Corps for the army. Six carriages will be placed in operation at military forts near Washington, and will be employed in maneuvers. The wagons will be specially adapted for use in mountainous Western regions of the United States. The air wire, which is of fine steel, is elevated by means of a small captive balloon or by a kite, if the weather is favorable. The system employed is that invented by Prof. Braun and used in the last German maneuvers in the presence of Generals Corbin, Young and Wood. Fifteen carriages will be sent in all to the United States and several will be shipped likewise to the Philippines for active service. Two carts will be used, the first containing the wireless apparatus and a rear carriage with a benzine motor. It is proposed to carry wireless messages a distance of 100 km (63 miles). Herr Georg Seibt, director in charge of the wireless department of Siemens & Halske, stated that no greater distance is desired than from 50 to 60 miles in transmitting messages from one corps or point of military operations to another. In a short time all the big armies of the world will be equipped with wireless portable stations, as the firm have orders from France, England, Russia, Belgium, Sweden and many other countries.

WIRELESS TELEGRAPHY ON LONG ISLAND SOUND.—A wireless telegraph station is being constructed at Fort Schuyler, on Long Island Sound, and another will be erected at Fort Fisher, on Fisher's Island, at the northern entrance to the Sound. The towers for the stations are to be of steel and 200 ft. high. The stations are expected to be in working order by the beginning of summer, and when completed they will be operated by electricians in the army service.

ARC LAMP PHOTOMETRY.—The committee on photometric values of arc lamps of the National Electric Light Association, of which Mr. Henry L. Doherty is chairman, is making a very elaborate report of the tests that have been carried on during the past year at Purdue University under the direction of Professors Goldsborough and Matthew. The committee will present at the convention to be held at Chicago May 26, 27, 28 the results of comparative tests of arc, incandescent, Nernst and Welsbach lights, and some very interesting data are expected.

NOVEL MESSENGER SERVICE.—At Toledo, Ohio, Miss Mayme Hartzell, a twenty-year-old girl living with her parents, has opened an office in the Nasby Building and started what she calls the Toledo Messenger Service. She proposes to do business in competition with the American District Company, and her only difficulty thus far has been in securing a sufficient number of boys, so rapidly is her business growing, it is said, owing not only to the novelty of the institution, but to her clever business methods. She is a telegraph operator also. This knowledge she picked up when but thirteen years of age by visiting a railroad office, her father being an employee of the Ohio Central.

VARIABLE-POLE, ALTERNATING-CURRENT MOTORS.—A patent issued April 14 to R. Dahlander and K. A. Lindstrom, of Westeras, Sweden, describes a method of winding alternating-current motors, whereby the conductors may be coupled to vary the number of poles. The conductors or groups of conductors for the several phases follow each other in regular progression around the member on which they are wound, and are connected to form separate windings for separate phases. The winding for each phase is divided into two sections with a terminal connection so arranged that the several windings may be so connected to cause the current to flow in the same direction through both sections of each winding, or the direction of current flowing in one of the sections may be reversed. The claims apply to induction and synchronous motors having drum windings.

ALTERNATING-CURRENT RAILWAY MOTOR.—A double-circuit alternating-current railway motor is the subject of a patent granted April 14 to Sigvald Krohn, of Berlin, Germany, which has been designed to obviate the objection to the general employment of high voltages, owing to danger from a high-potential trolley line in the streets of a town or towns through which a railway passes. The patent describes a motor of special construction, the movable member being provided with both a high-potential and a low-potential winding. When the motor receives current from a low-potential trolley, the high-potential winding is closed upon a variable resistance. On the other hand, when the motor receives current at high potential, the low-potential winding is closed upon a variable resistance; the resistances in either case may be cut in or out to any extent desired or short-circuited. The claims apply to the use of the invention in connection with induction motors.

CONNECTICUT HIGH-SPEED TROLLEYS.—It is reported in New Haven, Conn., that the New York, New Haven & Hartford Railroad Company will convert its Harlem River branch into a high-power electric passenger line, and by connecting it with its trolley system running west from Stamford, Conn., form a fast electric route to compete with the New York & Port Chester Electric Road. Officials of the New Haven road will say only that the project is under consideration. It is expected that the new Port Chester line will make very fast time between Port Chester and New York, and if the New Haven system expects to compete for this local traffic it is said that it will have to put in a first-class electrical equipment along the lines indicated. The Union Railway Company, a trolley line which says it has cut into the New Haven's local traffic to New York from New Rochelle, now complains of the legislation against it at Albany, N. Y., and claims that it is inspired by the New Haven system.

ST. LOUIS EXPOSITION LIGHTING.—Plans for the illumination of the central tower of the Administration Building of the Exposition have been perfected by Chief Electrical Engineer Henry Rustin. The tower will stand out a blaze of light, produced by 6,000 incandescent lamps. The current for this will be drawn from the power plant on the University portion of the grounds. The vertical line of the two hexagonal turrets on the front of the tower will be marked out in lines of light. A line of light will also mark the archway. Between the two turrets a giant American flag, occupying the entire space, in red, white and blue, will wave in the breeze. This effect will be produced in what is known as the Elblight system, in which two heavy cables formed of very thin copper wires are woven into a rope and properly insulated, side by side and touching in parallel lines. The lamp used is provided with two sharp points, which are forced into the cable and form a contact by penetrating between the strands of the wire rope. The advantage of this is that a lamp can be located at any point in the cable without the necessity of a socket. The flag will be supported from an iron cable by rings so that even a slight wind will move it to and fro, giving it a curious effect. The entire composition will have the effect of a giant construction of light supporting the flag. It is the intention to operate this illumination during the entire dedication period.

PHASE TRANSFORMATION.—Among the patents of April 14 are two issued to Messrs. J. F. Kelly and C. C. Chesney, which relate to a method of phase transformation. By this method the circuits of, say, a three-phase generator or the three secondaries of three transformers supplied by three-phase currents can be combined to produce two currents in quarter-phase; or the circuits of a two-phase generator or the two secondaries of two transformers supplied with two-phase currents can be combined to produce three-phase currents. As applied, for example, to a star-wound three-phase generator, one of the three armature windings is separated into two parts, each being in length .366 of each of the two other generator circuits. By a suitable connection of the terminals of these several windings, two-phase currents are derived. It is also shown how in the same manner three-phase currents may be taken from a generator supplied with a two-phase winding. As applied to transformers, two of the three transformers on a three-phase circuit have the usual winding; the secondary of the third winding is divided into two sections, each equal in length to .366 of either of the other two secondaries. By means of switches, the two-phase circuits may be made to correspond to primary three-phase circuits fed either by star or delta-wound generators. A second patent relates to a means for regulation in connection with the above phase transforming method.

SELECTIVE WIRELESS TELEGRAPHY.—Among the patents of April 4 are four on systems of selective wireless telegraph, one being issued to Nikola Tesla and the others to John Stone Stone. There is much similarity between the inventions described, which in both cases have been the subjects of previous patents. In each case the principle consists in transmitting a signal in waves of two or more frequencies, which implies two or more antenna and transmitting circuits controlled simultaneously by the sending key; and the same number of receiving antenna and receptive circuits, each of the latter being tuned to one of the transmitting circuits. A relay connected in common to the two or more receiving circuits can only be actuated when these several circuits respond simultaneously to waves received. As a consequence, no signals will be received unless they are transmitted in multiple waves of the exact frequencies for which the multiple transmitting and receiving circuits are tuned, the result being that the chances of interference are infinitesimal as are also the chances of a message being read at any other wireless station than that for which it is destined. The Tesla patent is the earliest in date of application (July 16, 1900) and relates to means for transmitting simultaneously the waves of different frequencies and the means of completing the conjoint recording circuit of the receiving station. The Stone patents (the applications for which were filed in January and March of the present year) deal with the same subjects, but with much more elaboration with respect to the character of the signals.

NEWS BY WIRELESS TELEGRAPHY.—A special dispatch from London of April 18 says: The *Times,* which for several days past has printed no dispatches received by the wireless system of telegraphy, a service which was inaugurated a few weeks ago, announces that the service has been temporarily abandoned, owing to the breaking down of a subsidiary device employed in connection with one of the Marconi company's stations. The company announces that repairs will shortly be made.

N. E. L. A. SPECIAL TRAIN.—Mr. C. O. Baker, Jr., master of transportation of the National Electric Light Association, is now planning to run a special train from New York to Chicago for the convention in the latter city, beginning May 26; and as a given number of passengers must be guaranteed, it is earnestly requested that all prospective attendants from the East likely to go on the train will send in their names at once to 136 Liberty Street and also mention the matter to their friends.

DIGEST
OF
CURRENT ELECTRICAL LITERATURE.

DYNAMOS, MOTORS AND TRANSFORMERS.

Resonance Phenomena.—Some editorial notes on Field's recent paper on the study of resonance in the electric circuit, by the aid of oscillograms. He has examined the phenomena experimentally on a large scale, the tests being made in the plant of one of the largest English generating stations. He points out the possible danger of destructive resonance due to the high-frequency harmonics caused by uneven distribution of the armature conductors. The effects of resonance may become dangerous if their possibility is ignored, but in nearly all cases they can be easily avoided. While there is thus no reason for alarm, there is always good reason for making sure that the danger of resonance can be neglected. None of the extraordinary cases shown by Field occurred when there was any appreciable load on the circuit, but only when the generators were merely loaded with the transformers and the cables. The resonance was due to synchronism between the higher harmonics of the potential wave and the rapid oscillatory discharge current between the cable and transformer windings. The effects described by the author point to the desirability of giving preference to alternators whose voltage waves are smooth. The ripples caused by the uneven distribution of the armature conductors can be made negligible by choosing higher engine speeds. The alternators will then have fewer and larger poles, thus allowing a greater number of slots per pole and a better distribution of the armature bars.—Lond. *Elec.,* April 3.

Insulating Paints for Electric Machines.—Farrington.—A paper in which he points out that the use of defective insulating paints or varnishes is the reason of most break-downs of electric machinery, occurring at the present time. An insulating varnish or paint is used for the sole purpose of keeping constant the initial insulation resistance of the cotton covering. He therefore discusses the various points of weakness of cotton covering. He describes a long series of tests which he has made to find a satisfactory insulating material which will preserve the insulating properly of the cotton, and he points out that it should never contain linseed oil, on account of the extreme rapidity with which it absorbs oxygen; it continues to oxidize until it becomes a brittle, cracked mass. Electrical engineers when claiming good ventilation for their machines, should not forget, that well ventilated may also mean well oxidized. No insulating material of acid composition should be used; users of shellac, copal varnish, and linseed oil varnish as insulation have frequently found that the cotton covering of their wire has been turned to a brilliant green, which is a sure indication that the copper has been attacked by the acid and that a radical change has gone on within precincts where chemical changes should be excluded with great care. It is feasible to get a good non-acid insulating material by working in the paraffin series.—*Electrochem. Ind.,* April.

LIGHTS AND LIGHTING.

Life Tests of Nernst Lamps.—Stottner, Bailey, Robinson.—Several communications on the life of Nernst lamps in laboratory tests and in actual operation: the Nernst lamps referred to are those made by the General Electric Company of Berlin, which sells the lamps to customers. Stottner (who is an engineer of that company, and recently read a paper before the [Brit.] Inst. of Elec. Eng.), refers to laboratory tests made at the Faraday house; the average life of the Nernst lamp was found to be over 500 hours.—Lond. *Elec.,* March 13. Bailey had tested Nernst lamps in the laboratory and found the life to average about 300 hours, which agrees with the results obtained by the Reichsanstalt and with the claims of the manufacturers; in these tests the lamps were run continuously. In practical use, however, he and others found the life to be much smaller; "something between 50 and 100 hours seems to be the outside average life that we are obtaining." In the latter commercial tests the regulation is good, never more than 5 volts too high, or under 3 per cent.; there was no considerable vibration. The only explanation which he finds for the shorter life in actual use is that the lamps are frequently turned on and off, whereas the laboratory tests were continuous runs. As the filament becomes completely crystalline after a few hours, it is naturally very brittle and the repeated heating and cooling causes it to snap; it usually breaks at the negative end of the filament. The lamps tested by him were all of the large type, nominally 1 amp., 230 volts, with vertical filament. He states that the small lamps with horizontal filament seem to be doing much better, but that his experience with them has not extended over so long a time.—Lond. *Elec.,* March 20. Robinson has found that the automatic cut-outs in the pattern of the Berlin General Electric Company are not sufficiently substantial, and that, generally when there is "no apparent cause" for the failure of the lamp, it is due to the faulty action of the cut-out; the cause being the fusing of the heating coil without the rupture of its protective covering, due to its being accidentally left in parallel with the glower. Another weak point is the resistance holder, which frequently breaks away from the porcelain base. The burner is the place where there is most room for improvements. He tested 186 burners at Harkney, 141 being of the ½-amp. type and the remainder of the 1-amp. type; the lamps are hung on springs from a swan's neck carrier fixed to old gas standards in a street where the traffic is moderate; they are run during ordinary lighting hours and are switched on and off once a day. The declared pressure is 240 volts direct current, and the variation does not exceed 3 per cent. above the declared pressure; the average life of the ½-amp. lamps was found to be 334 hours; that of the 1-amp. lamps 370 hours. He cannot yet state the full life of the regulating resistances. So far only five have failed and they have an aggregate life of 6,665 hours.—Lond. *Elec.,* March 20.

POWER.

Electricity in Mining.—A note on the Tredegar Iron & Coal Company's collieries, situated in the Sirhowy Valley, Monmouthshire, the whole of which are now equipped with electric haulage, the pumping being also done entirely by electric power. The generating plant consists of two 300-hp engines coupled to three-phase generators at Ty Trist Pits, with an overhead transmission line of 2,000 volts to the Bedwellty Pits, a distance of about 1¼ miles. The plant is the largest of its kind in England, and no accident has yet happened there, special precautions having been taken to insure safety, as these pits are somewhat fiery.—Lond. *Elec.,* March 13.

TRACTION.

Interurban Electric Railways.—Gonzenbach.—A continuation of his serial on engineering preliminaries for an interurban electric railway. He discusses the transmission line, the distributing system and the third rail. Two absolutely independent pole lines are recommended and it is proposed that each follow its own route to the end of

the line. It is also recommended that the poles be spaced 132 ft. apart, 40 to the mile, and that the average height be 35 ft. In very few cases in cross-country roads they will be obliged to be as high as 50 ft. The practice of using wooden pins boiled in paraffin for their insulating properties, is being gradually abandoned and dependence placed entirely on the insulator itself, which is generally made of porcelain to stand a voltage as high as 33,000, although glass insulators have been used on lines carrying 40,000 volts. Instead of adopting a systematic spacing of sub-stations along the line, the writer proposes that they be placed regardless of any uniform distance and as near the center of towns as the limitation imposed by a high-tension line and the extent of real estate will permit. The object of this arrangement is to employ them as electric light and power stations for the places in which they are located, as well as for passenger, express and freight depots, and also to permit the company to have a representative at each of these places to handle the business on practically the same lines as on steam roads. The plans for an interurban station along these lines is presented and its advantages explained. Shunt-wound rotaries having a considerable drop in their characteristic curves between full load and 100 per cent. over load, are recommended, as they can properly handle the load imposed where there are several cars near one station. As sub-stations will also act as distributing centers for lighting and power, a motor-generator set should be added. This should consist of a 60-cycle, 2,200-volt, two or three-phase generator, directly connected to a synchronous motor. The conductivity of the third rail as compared with copper is discussed in determining the size of the rail and some of its details. At highway crossings the third rail has to be interrupted, and the car drifts across. The writer proposes that the third rail be extended into the public highway and protected by a high fence and an automatic cut-out, leaving it dead except when a car passes over it. A passageway for teams could be left 25 ft. wide, and this could be easily spanned by the shoes of the car so that the lights will remain burning.—*St. R'y Jour.*, March 28.

Economy of Rural Railways.—An editorial discussion, with reference to the report just issued by the railroad commissioners of one of the New England States, showing that the rural railways in that State were doing little more than paying fixed charges, and that no dividends had been earned. This is not considered necessarily an evidence either that the railways are badly managed or unwisely built. A considerable number of roads are built largely on the proceeds of the sale of their bonds, so that return on the capital stock is often pure profit. It is believed that the return on the cash investment would usually show a fair profit. In addition the editors refer to the fact that many roads are built for summer traffic only and that there is very little profit in such a business. Such a road should not only keep expenses down, but should endeavor to build up a freight, mail and express business.—*St. R'y Jour.*, April 4.

Interurban Map of Wisconsin.—A map showing the electric interurban lines already built and those under construction in the State of Wisconsin. The most important center of interurban communication in that section is Milwaukee. Lines extend from that city to Waukesha, Pewaukee Lake, Kenosha and thence to Waukegan. The next important district is in the Fox River country, while in the southern part of the State several roads centering in Rockford, constitute another field. There is also a line from Madison to Fond du Lac.—*St. R'y Jour.*, April 4.

London.—A note on a recently-opened extension of the London United Tramways Company. The new section is seven miles in length and is fed from a sub-station at Tulwell. Current is supplied to the sub-station from the powerhouse at Chiswick by means of three-core, three-phase cables with 5,000 volts on each phase; at the sub-station the voltage is reduced to between 410 and 450 and six-phase synchronous converters change the current to between 500 and 550, direct-current. There is also in the sub-station a booster in circuit with the insulated return from the rails, whose fields are excited by the positive feeder, and which is motor-driven. In the other sub-stations these boosters will be driven from the shafts of the synchronous converters. Current for lighting the sub-station is taken from a separate 10 to 1 transformer and the lamps are wired five 100-volt lamps in series, so that should the alternating current fail, they may be worked from the line. In the powerhouse a new 1,000-kw steam-driven, 5,000 volt star wound generator has been installed, the frequency being 25 periods per second.—Lond. *Elec.*, April 3.

Ilford.—A note on the new Ilford tramways. There are altogether 4 miles of double and 2½ miles of single track, forming three distinct routes.—The gauge is 4 ft. 8½ in. and the rails 100 lbs. to the yard. The feeders consist of lead-covered cables drawn in pipes under the footpath and have a cross section of 0.35, 0.25 and 0.15 sq. in.; the 0.35 reduces down to 0.25 and then to 0.15 at different distances along its length. There is a 0.5 insulated return to which the rails are connected at frequent intervals. Power is supplied from the lighting generators, which are compound wound, and give 500 volts, but only 460 when the shunt winding alone is excited.—Lond. *Elec.*, March 13.

REFERENCES.

Multiple-Unit Systems.—An editorial note on the subject of multiple-unit systems operating on low voltages. Where the system depends upon the action of magnets, some difficulty may be experienced in operating with a low voltage and this should be guarded against.—*St. R'y Jour.*, April 4.

Handling Freight on Interurban Electric Lines.—HAWKS.—A communication contending that the idea of operating electric lines as competitors of steam railroads for handling freight, is entirely erroneous. He believes that the electric roads should occupy an entirely different field from the steam lines, and he points out where each has its advantages.—*St. R'y Jour.*, April 4.

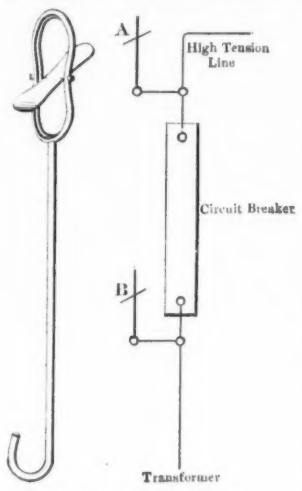
Freight Traffic.—An account of the methods employed by an agent of the Rockford Interurban Railway Company in developing freight and passenger business.—*St. R'y Jour.*, April 4.

Municipal Ownership in Germany.—HEYN.—An article on recent history of the municipal ownership of street railways in Germany. Of 133 German cities, 18 own their own street railway systems. A list of these cities is given. German cities are increasing the number of enterprises in which the municipality engages. A short sketch is given of the attempt of the city of Berlin to secure the system of the Grosse Berliner Strassenbahn.—*St. R'y Jour.*, March 14.

Canal Hauling.—A well-illustrated article on the three-phase system installed on the Miami & Erie Canal, which connects the Ohio River at Cincinnati with the Lake Erie at Toledo.—*St. R'y Rev.*, March.

INSTALLATIONS, SYSTEMS AND APPLIANCES.

Current Indicator.—An illustrated description of a simple device of Gavotti and Senni-Guidotti for always indicating whether a certain part of a line is under current or not. It is formed of nickel-plated iron wire with a hook at the lower end and an oval ring at the upper end; in the center of the latter a thin aluminum plate is mounted which can easily revolve around its axle, as shown in the figure. One-half of it is slightly heavier than the other half, so that in general the plate will be in a vertical position. If it is, however, placed at the side of a conductor through which a current flows, the plate tends to occupy a horizontal position, due to "electrostatic effects." The diagram shows two such devices mounted at the ends of a circuit-breaker. If the device, *A*, is in the horizontal position and *B* in the vertical position, it means that the circuit-breaker has acted. If both *A* and *B* are horizontal it means that the current passes through the circuit-breaker.—*L'Ind. Elec.*, March 25.



CURRENT INDICATOR.

ELECTRO-PHYSICS AND MAGNETISM.

Radioactivity.—CURIE AND LABORDE.—A French Academy paper on the heat developed spontaneously and continuously by the salts of radium. A thermo-electric couple of iron and constantan, one of whose junctions is surrounded by radio-active barium chloride, indicates a difference of temperature between the two bodies. One gramme of radium discharges an amount of heat which is of the order of 100 gramme calories per hour (about 1-9th watt). One

gramatom of radium (225 grammes) would discharge during every hour 22,500 calories, a number which is comparable to the heat produced by the combustion in oxygen of 1 gramatom of hydrogen. The continuous development of such an amount of heat cannot be explained by an ordinary chemical transformation. If we look for the origin of the production of heat in an internal transformation, this transformation must be of a more profound nature, and must be due to a modification of the radium atom itself; such a transformation, however, if it exists at all, takes place with extreme slowness. The hypothesis of a continuous modification of the atom is not the only one compatible with the disengagement of heat by the radium. This disengagement of heat may also be explained by supposing that radium utilizes an external energy of an unknown source.—*Comptes Rendus,* March 16; abstracted in Lond. *Elec.,* April 3.

Crookes.—A communication in which he suggests the following hypothesis on the origin of the energy given off by radio-active bodies. He draws attention to the large amount of energy locked up in the molecular motions of quiescent air at ordinary pressure and temperature, which, according to some calculations by Stoney, amounts to about 140,000 foot-pounds in each cubic yard of air. He conjectures that radio-active bodies of high atomic weight might draw upon this store of energy in somewhat the same manner as Maxwell imagined when he invented his celebrated "demons" to explain a similar problem. He suggests that the atomic structure of radio-active bodies is such as to enable them to throw off the slow-moving molecules of the air with little exchange of energy, while the quick-moving missiles would be arrested, with their energy reduced and that of the target correspondingly increased. The energy thus gained by the radio-active body would raise its temperature, while the surrounding air would get cooler. To a question of an anonymous correspondent asking whether sodium should not cease to display its peculiar properties in a vacuum, Crookes answers that what we call a high vacuum is only a vacuum by courtesy; a glass bulb, 5 in. in diameter and exhausted to the millionth of an atmosphere, still contains more than a trillion molecules.—Lond. *Times,* reprinted in Lond. *Elec.,* April 3.

Electric Properties of Gaseous Mixtures.—Bouty.—An account of an experimental investigation of the effect of the electric discharge or "effluvium" upon gases. It is incapable of changing the physical or chemical constitution of the gas through which it passes. It does not explode an explosive mixture, nor does it produce an appreciable change in the pressure of the gas. He has also investigated the dielectric strength of mixtures of hydrogen with various other gases, confining his experiments to pressures above several millimeters of mercury. In one class of mixtures the critical field is the exact mean of the critical fields of the gases taken separately at the pressure of the mixture. Another remarkable case is the decided reduction of the critical field in a mixture of hydrogen and carbon dioxide.—*Comptes Rendus,* March 16; abstracted in Lond. *Elec.,* April 3.

The Metals and Maxwell's Theory.—Hagen and Rubens.—Maxwell's theory has hitherto been in contradiction with the fact that the series of metals arranged according to transparency is not the same as the series arranged according to resistance. Hagen and Rubens have, however, now found that the theory is strictly verified in a region of wave lengths where the natural vibration of the metallic molecules does not influence the result. At the greater wave lengths, platinum becomes distinctly more transparent than gold and silver, and bismuth, which intercepts 99.9 per cent. of ordinary light, intercepts only 90 per cent. of waves 4,000 $\mu\mu$ long. The transparency of these metals for long waves, cannot easily be observed since no carrier exists sufficiently transparent to bear the thin metallic sheets without disturbing the result. The authors, therefore, studied the reflective power of the metals in the shape of cast concave mirrors, 30 cm in radius and 4 cm in aperture. They found that as soon as the wave length becomes as great as 12,000 $\mu\mu$, the molecular vibrations of the metals are without any influence, and the transparency series is the same as the resistivity series. The magnetism of iron and steel cannot follow a frequency of 2.5 x 10 to the thirteenth power, vibrations per second, and so these metals also fit into the series.—*Sitzungsber Akad., Berlin,* 13, 1903; abstracted in Lond. *Elec.,* April 3.

Dielectric Constants of Liquids.—Tangl.—An account of observations extended over a wide range of temperature. The Clausius-Mossoti formula depends upon the temperature, and the present author has, therefore, investigated whether the formula could be used as an index of chemical change, more especially in view of the parallelism between dielectric constant and degree of dissociation indicated by Nernst. The results show that Nernst's method is available for certain temperatures ranges and materials; others show an anomaly in their dielectric constant at the critical temperature, it being still much greater than the square of its refractive index for infinitely long waves.—*Ann. d. Phys.,* No. 4; abstracted in Lond. *Elec.,* April 3.

Magnetic Susceptibility of Water.—Stearns.—An account of an experimental investigation in which a new determination of the magnetic susceptibility of water at 22° C. was made. It was found to be between —0.000000715 and —0.000000750, C. G. S. units, while the results of former determinations vary between —0.00000066 and —0.00000086. The great discrepancies between the results of the different observers have not yet been explained.—*Phys. Rev.,* January.

Electro-Chemistry and Batteries.

Artificial Graphite.—Fitzgerald.—A summary of the artificial graphite industry in 1902. The manufacture of graphite electrodes was not so large in 1902 as in the previous year, but the number of works in which the artificial graphite electrode is used has increased, as certain valuable properties have been recognized which were not fully appreciated before; among these are the resistance of graphite electrodes to oxidation when heated in the air, its high electrical conductivity, and the ease with which it can be machined. A new patented method for graphitizing electrodes is described in which most of the heat is developed in the higher resisting material placed in the spaces between the electrodes; the advantage of this method is that large furnaces can be used and yet the resistance kept sufficiently high to avoid the use of currents of very high amperage. A new patent process of making other forms of graphite is also described; it is based on metallic vapors acting upon amorphous carbon at the high temperature of the electric furnace; oxide of iron is reduced and the vapor of metallic iron acts upon the amorphous carbon, converting it into graphite. The manufacture of paint from artificial graphite has increased considerably, for it is now recognized that a greater purity and uniformity can be obtained than is possible with a natural product. The most marked increase has been found in the use of graphite for dry batteries. It is only within the last year that the problem of producing an artificial graphite lubricant for high-grade work has been successfully solved. The spontaneous ignition of high explosives is supposed to be caused occasionally by a static charge of electricity on the grains, thus causing a spark which detonates the powder; by coating the grains with graphite the formation of this static charge is prevented.—*Eng. & Min. Jour.,* March 28.

Use of Carbide of Silicon.—An article on the use of carbide of silicon, as a substitute for ferro-silicon, in the manufacture of steel. To insure solid castings, there should be a higher silicon content than can be secured from pig iron that comes within basic requirements. The addition of ferro-silicon causes difficulties, while carbide of silicon, containing 62 per cent. of available silicon can be added directly to the ladle during the process of tapping and without previous heating; uniform action is secured and complete solution generally takes place by the time the ladle is full. It is also used extensively in making steel for various purposes when it is first run into ingots, and in which there is much less silicon than in steel castings, amounting generally to but a trace. Manufacturers of tool steel have found that the freedom of carbide of silicon from phosphorus and sulphur offers great advantages, and it is, therefore, used in considerable quantities in the open hearth practice of such manufacturers and to some extent in crucibles. In the acid open hearth process carbide of silicon is also used for cleaning dirty furnace bottoms, as it readily reduces the residue to fluid slag, which is easily removed from the hearth.—Cleveland *Iron Trade Rev.; Eng. & Min. Jour.,* March 28.

Acetylene Dissolved in Acetone.—Hutton.—An article on a recent method introduced by a French company for storing acetylene gas so that there is no danger of an explosion. The acetylene is dissolved in acetone; but as this dissolution is accompanied by a considerable increase of volume, a free space would be formed in a cylinder containing acetylene dissolved in acetone when the gas is drawn off for use; this free space would then be filled by acetylene

gas and there would again be danger of an explosion. This disadvantage is said to be entirely overcome by filling the cylinder with a porous material, such as porous bricks or specially prepared cement of a low density and of high porosity. The gas may then be stored under pressures without the least fear of an explosion.—*Electrochem. Ind.*, April.

Voltameters with Platinum Electrodes.—BARTORELLI.—A study in detail of the polarization and resistance of voltametric cells consisting of platinum electrodes dipping into a more or less concentrated solution of sulphuric acid. He finds that the polarization increases with the current, but not in proportion to it. A maximum is attained and is maintained for all higher values, a result which is of importance, with regard to the ionic theory. The value of the maximum polarization varies from 2.7 to 2.9 volts from a concentration of 1 per cent. to a concentration of 15 per cent., and is, therefore, nearly constant. The conductivity also shows a very similar behavior, also with a constant maximum. In the case of platinum as well as aluminum electrodes, the resistance at high values depends almost exclusively upon the surface of the electrodes, and the variations are, therefore, properly of the surface of the electrodes, and may be called resistances of transition.—*Phys. Zeit.*, March 15; abstracted in Lond. *Elec.*, March 27.

Aluminum.—J. B. C. KERSHAW.—A statistical article on the present state of the aluminum industry. The number of plants where aluminum is produced either by the Hall of by the Heroult process, is at present nine: America, 3; France, 2; Germany, Great Britain, Switzerland and Austria, each 1. The total power available in these is between 36,000 and 40,000 hp, all of which is water power. The total combined output is estimated as 7,240 tons in 1901 and 8,000 tons in 1902. Some information is given on the financial conditions of the various companies and the dividends paid by them.—Lond. *Elec. Rev.*, March 20.

REFERENCES.

American Automobile Batteries.—A continuation of the illustrated serial in which descriptions of the Madigin battery and of the Clare battery are given.—*Electrochem. Ind.*, April.

Concrete Tanks.—BROWNE.—An article on tanks suitable for use in the electrolysis of chloride solutions. While slate tanks are satisfactory, they are expensive and require much care in installing. He has found concrete to be an efficient substitute for slate and describes in detail how to make them.—*Electrochem. Ind.*, April.

Copper Process.—JOHNSON.—An illustrated detailed description of the plant of the International Copper Company, at Dorchester, Canada, and of the Carmichael process for producing copper from its ores, used at this plant.—*Electrochem. Ind.*, April.

Aluminum Bronze.—SPERRY.—An article on the good forging properties of aluminum bronze.—*Metal. Ind.*, April.

Direct Combination of Chlorine with Carbon.—BOLTON.—A brief note supplementing the results given in a former paper. If the carbon arc is formed in a chlorine atmosphere in a large space, C_2Cl_6 is formed; if, however, the reaction takes place in a confined space, C_6Cl_6 is formed.—*Zeit. f. Electrochem.*, March 5.

Antimony.—A description and critical discussion of the Izart and Thomas process for the production of antimony from the ore.—*L'Ind. Electrochimique*, March.

Metallurgy.—SCHNABEL.—A summary for the year 1902 of the progress made in various metallurgical processes, more especially for getting from their ores gold, silver, copper, lead, zinc and nickel. The descriptions are mostly brief and are taken either from articles in other journals or from patent specifications.—*Glueckauf*, February 28.

Calcium Carbide.—CARO.—A long critical discussion of the process patented by Diester.—*Zeit. f. Calciumcarb. Fab.*, March 20.

Electric Iron and Steel Processes.—SIMPSON.—An article in which he discusses, from a commercial standpoint, the electric reduction of iron ores and the conversion of iron into steel in the electric furnace. The conditions under which such a process may be a financial success, are pointed out.—*Electrochem. Ind.*, April.

Electric Steel Furnace.—BECKER.—An illustrated description of the Kjellin electric furnace for making steel, in use in a Swedish plant.—*L'Ind. Electrochimique*, March.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Potentiometer for Thermocouple Measurements.—LEHFELDT.—An abstract of a Brit. Phys. Soc'y paper in which he describes the construction of a potentiometer for thermo-electric work. For such purposes it is essential that the potentiometer shall not introduce a high resistance in the circuit of the couple and galvanometer; most of the potentiometers in the market fail in this respect. In his apparatus the current flows from the positive terminal of an accumulator to a switch by means of which it can be sent through 100, 1,000 or 10,000 ohms, in order to get three grades of sensitiveness; it then passes through 20 coils of 0.1 ohm each, a slide wire of a little more than 0.1 ohm, and through an adjustable resistance back to the accumulator. The fixed resistance of 100, 1,000 or 10,000 ohms is shunted by a cadmium cell and a galvanometer, and the adjustable resistance is varied until balance is obtained. The thermocouple and the galvanometer are then just across any number of the tenth-ohm coils and any fraction of the slide wire. Great care has been taken to avoid accidental thermo-e.m.f's which are the chief trouble in using thermocouples. The only metals used in the measuring circuit are copper and manganin. The position of the sliding contact upon the bridge wire can be read by means of a vernier to one-fortieth of a millimeter, corresponding to one-four-thousandth of the unit used, which may be 1,000, 100 or 10 microvolts, according to the fixed resistance used.—Lond. *Elec. Rev.*, March 27.

Harker.—An abstract of a Brit. Phys. Soc'y paper in which he describes an instrument similar to that noticed in the above abstract. The main current from an accumulator flows through a series of resistances, any one of which can be short-circuited at will, and then through the balancing coils. By means of the adjustable resistance the standard cell employed can easily be made to cut off from the main circuit a resistance numerically equal to 100 times its e.m.f., and therefore 1 ohm on the potentiometer circuit is always equal to 0.01 volt. The balancing coils consist of 20 coils of 0.1 ohm each in series with 11 coils of 0.01 ohm each. Any two of these latter coils can be put in parallel with a slide wire of 0.02 ohm resistance. The slide wire is provided with a scale of 200 divisions, and as the fall along the wire is 100 microvolts, 0.1 microvolt can easily be estimated. The slide wire acts as a vernier to the small coils. Copper and manganin are the only metals used, and the connections are made by means of mercury cups. In the discussion, Price referred to the large number of coils requiring calibration in the instruments of Lehfeldt and Harker. In working with sliding contacts in a dusty workshop it is an advantage to immerse the bridge in paraffin oil. The contacts are then always good instead of uncertain and intermittent.—Lond. *Elec. Rev.*, March 27.

Resistance Comparator.—LEHFELDT.—An abstract of a Brit. Phys. Soc'y paper in which he objects to sliding contacts on account of the thermo-electric effects they tend to introduce, and on account of the irregularities which slide wires tend to show when used frequently. He has substituted for the slide wire two coils, each of 99 ohms, each one is connected with 20 coils of 0.1 ohm each. The latter are arranged circularly, so that a switch connected to the galvanometer may be set on any one of the intervening studs. The galvanometer deflections are taken for the two positions nearest to the balance, and he interpolates between these. In this way an accuracy of one part in 100,000 is attainable. He thinks there is a gain of accuracy as well as of convenience in using the interpolation method.—Lond. *Elec. Rev.*, March 27.

MISCELLANEOUS.

The Mercury Vapor Lamp for Eye Investigations.—A note on some observations made by Mayou, who, by means of the Cooper Hewitt lamp, examined a number of fundi, both normal and diseased. When examining the fundus of the eye by ordinary light, the large number of red rays reflected from it tend to mask some of the detail, and this is especially the case in diseases of the retina and with the fine terminations of the arteries. In examining the fundus with the mercury vapor lamp, he found that the "back ground" appears pale green instead of the usual red, the vessels appear purple, standing out with unusual distinctness, and the arteries, being of the same color as the veins, can be traced to their finest ramifications. The choroidal vessels are of a deeper purple, and over the whole the retina can be seen glistening, being especially well marked along the arteries and veins. The optic disc appears with a white center and green edges. He thinks that the mercury vapor lamps should

be of considerable utility in the differential diagnosis of retinal and choroidal disease, since the perspective of the retina, choroid and sclera is very clear.—Lond. *Elec.*, April 3.

Institution of Electrical Engineers (*Brit.*)—The new president to succeed James Swinburne, is R. K. Gray, the director of the Indian Rubber, Guttapercha & Telegraph Works Company. He will represent the Institution at the forthcoming International Telegraph Conference.—Lond. *Elec.*, April 3.

REFERENCE.

Electric Igniters.—SALOMONS.—The first part of a long article in which he discusses the various methods of electric ignition in gas engines.—Lond. *Elec. Rev.*, March 27.

The Cascade Water, Power & Light Co , Cascade, B. C., Canada.

BY W. G. MCCONNON.

The Cascade Water, Power & Light Company, situated at Cascade, B. C., and owned by the London & British Columbia Goldfields Company, Limited, has recently completed a water power electrical plant representing an investment, in round numbers, of $500,000. Cascade

FIG. 1.—EXTERIOR OF POWER HOUSE, SHOWING PIPE LINE.

is a small town on the Kettle River, twelve miles east of the town of Grand Forks, and about thirty miles directly west from Rossland, B. C. Flowing from the west the Kettle River descends 120 ft. in passing through a half mile of narrow rocky gorge in a series of rapids and falls. For the utilization of this natural power, the Cascade Water, Power & Light Company has built a large dam, waterway, pipe line, power house and transmission line from Cascade to Phoenix, where the largest and most productive copper mines in the "Boundary District" are situated.

The dam, placed just above the entrance to the gorge, is of timber cribwork, with a 40-ft. base and 24-ft. top. The mid-section is 50 ft. high, tapering to 25 ft. at the sides, while the total length is 400 ft. This is built on a solid rock bed to which the foundation timbers are bolted, and filled with 10,000 cubic yards of rock. This dam raises the water 36 ft. above the natural level, giving an effective head at low water of 156 ft.

The permanent water level is 10 ft. below the top of the dam, being controlled during high water by twelve sluiceways, which can be opened to 12 ft. below the natural river level, giving a passway of about 2,000 sq. ft. These sluices are closed by means of 12-in. x 12-in. squared timbers in grooves, operated by a traveling winch running on a track over the top of the dam.

From dam to power house the water first passes through a 225-ft. open rock cut from which it enters a tunnel driven through 410 ft. of solid rock, passing under the track of the Canadian Pacific Railway, and then into another open rock cut 500 ft. in length, at the end of which the bulkheads and controlling gates are located. These cuts and tunnel, representing an excavation of about 35,000 cubic yards of rock, are of dimensions liberal enough to avoid any appreciable loss of head, delivering the water with a head almost equal to that at the dam level.

From the gates the water is conveyed through a wooden pipe 7 ft. in diameter, for about 1,400 ft. This pipe is constructed of Oregon fir tongued and grooved staves 2¾ in. x 7 in., cut in circular segments and machined to the radius of the pipe. The staves are hooped at 12-in. intervals, with ¾-in. round steel bands, with cast-iron connecting shoes for clamping. Provisions have been made at the bulkhead and in the width of the cut for the installation of a similar and additional pipe.

From the stave pipe the water is carried through 250 ft. of circular steel pipe, 7 ft. diameter, resting on concrete piers and anchored into solid rock to avoid end thrust. Where this pipe passes alongside of the power house, three 4-ft. pipes and one 2-ft. pipe are taken off below the floor level of the power house to supply three 36-in. turbines for generators and two 12-in. turbines for exciters.

Fig. 1 is a general view of the power house showing the stand pipe at the junction of the stave and steel pipes. This stand pipe relieves the pipe line from excessive water-ram strains, and incidentally voids any air taken into the pipes. About 10,000 cubic yards of rock were removed for the site of the power house, in a natural bay at the foot of the falls. This building is of substantial fire-proof construction, 150 ft. x 50 ft., with stone foundation 22 ft. deep on the lower side, and brick walls 30 ft. above floor level, the height to peak of roof being 45 ft. It has been designed with a view to lengthening it when required.

Figs. 2 and 3 show the interior of the power house, and the generating plant. The three generators are standard Westinghouse, three-phase, two-bearing, direct-coupled, 2,200-volt, 750-kw, at 80 per cent. power factor, or 940 kw at 100 per cent. power factor, 60 cycles per second, 300 r.p.m. The two exciters, each capable of exciting all three generators at one time, are 45-kw, 120-volt, shunt-wound dynamos, self-contained, two-bearing type, direct-coupled to independent turbines, with 500 r.p.m. The turbines are S. Morgan Smith wheels made at York, Pa., and the governors of the Escher-Wysse make, from Switzerland.

Fig. 3 shows the transformers, nine in all, three in each bank, which are the standard Westinghouse, self-cooling, oil-insulated type, having a capacity of 250 kw at 80 per cent. power factor, or 312½ kw at 100 per cent. power factor, star connection, and wound for a ratio of 2,000 to 20,000 volts, on both high and low-tension windings, with full load efficiency of 97.6 per cent. As the taps are brought out near the neutral point, which is grounded, it is impossible to maintain a dangerous voltage in the auxiliary circuit.

The current from the high-tension side of the transformers is carried to a row of high-tension fused circuit-breakers, situated alongside of the building behind the main switchboard. These switches are placed on independent marble slabs, with marble barriers between. The current leaving these switches enters a high-tension bus and is carried to the line switches at the rear of the building. These line switches are grouped switches opening all three wires at the

FIG. 2.—INTERIOR OF POWER HOUSE.

same time. Each switch is furnished with a time limit tripping device, and reversed current tripping coils, so that overloads can be carried for a period of from one to ten seconds, as the local conditions call for, or either line can be cut out automatically in case of trouble.

The switchboard for the low-pressure side consists of seven panels of blue Vermont marble, one panel for each generator, one for the two exciters, and a feeder panel for each group of transformers. The six lightning arresters, located just above the switches in the

gable of the roof, are the "low-equivalent" style of Wurts arrester, giving protection against lightning discharges for transmission at 20,000 volts.

A right of way 132 ft. wide is cleared, and transmission lines erected from Cascade via Grand Forks to Phoenix, a distance slightly over 21 miles. The high-tension circuit consists of two separate three-phase transmission lines, each carrying three No. 3 B. & S. copper wires, with room on each line for another circuit. Throughout it is one of the most substantial and well constructed lines in the Dominion.

FIG. 3.—INTERIOR OF POWER HOUSE, SHOWING TRANSFORMERS.

The poles are heavy cedar, and on tangents are spaced not over 100 ft. apart, on curves at less distances, in some cases as low as 50 ft. No angles are turned, but all changes in direction of line made with easy curves. No side or head guys have been used except at extra heavy spans across rivers, etc. The work on this line, as well as all construction of the plant, is a decided credit to the company's local engineer, Mr. William Anderson, who has designed and executed the work.

A three-mile feeder is taken off at Grand Forks, 12 miles from Cascade, to the Granby Smelter of the Granby Mining & Smelting Company, where current is used for driving Westinghouse induction motors of sizes ranging from three to seven hundred horse-power, and of an aggregate capacity of 2,400 hp.

The sub-station at Phoenix, located at an altitude of about 3,500 ft. above the power house, is of brick, with one end left for future extension, and contains the transformers, line switches, fused circuit-breakers, switchboards, etc., substantially duplicating those at the power house. Fig. 4 shows the interior of this sub-station, which, for the immediate present, will be called upon to supply current for two 700-hp induction motors for driving two large compressors; a 100-hp motor for stone crusher, and a 150-hp motor for hoist as well as furnishing the current for lighting the town of Phoenix.

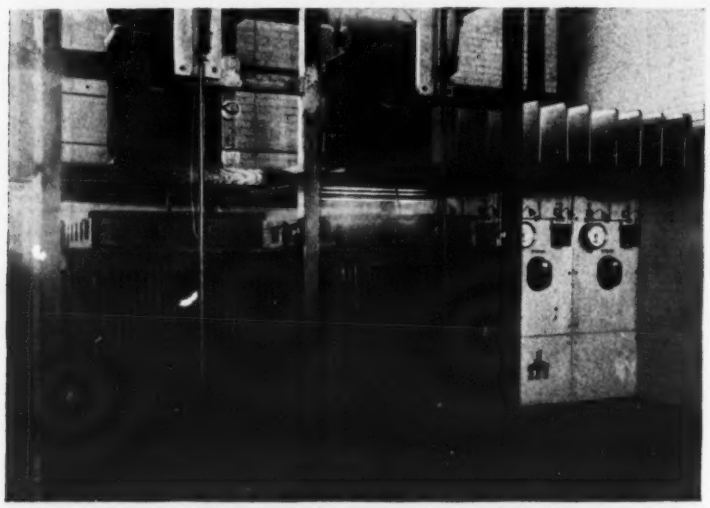


FIG. 4.—PHOENIX SUB-STATION.

The Cascade Water, Power & Light Company estimates that it will have a supply, at low water, for about 6,200 hp. This will enable the doubling of the present output. All the plans were made and carried out with the view of extending the plant to its full capacity, and from present indications it would seem that the company will have a demand for all the power it can furnish.

Development in Telephone Switchboard Equipment at Bloomington, Ill.

The telephone switchboard apparatus and instruments recently installed by the Equitable Construction Company, of Chicago, to enlarge and re-equip their plant at Bloomington, Ill., shows one of the most marked advancements that has been made lately in telephone systems. This exchange was one of the first plants in the independent telephone business. It was started early in 1895 with less than 100 subscribers. The outside lines were constructed with common return circuits and the plant was equipped with the old style individual generator call and local battery instruments, with a straight trunking switchboard.

The plant had a constant rapid growth and a year ago reached 700 subscribers, which was far more than at first calculated; and in order to accommodate additional subscribers who were rapidly applying for service, it was necessary to reconstruct the lines upon a much larger scale. In rebuilding the plant, the heavy aerial lines and all the lines in the main business district were replaced with an underground system. In the outlying districts a large amount of cable was substituted for open wires. The system was changed from the common return circuit to a full metallic circuit.

FIG. 1.—VIEW OF BACK OF TELEPHONE SWITCHBOARD.

After the outside lines had been practically rebuilt to an ultimate capacity for the accommodation of 2,500 subscribers, it was then necessary to increase their central office apparatus. After a thorough investigation and a careful consideration of estimates for increasing their old board and also for re-equipping their system, it was decided to install, as rapidly as possible, the new central energy system put on the market by the International Telephone Manufacturing Company, of Chicago. One of the features of the International system which made it especially adapted, and which was considered of vital importance, is that the board and central office apparatus may be installed first as a trunking system and the old telephones used as automatic signalling instruments and replaced gradually, at intervals, with strictly central energy instruments as rapidly as required and the multiple jacks and wiring, etc., added to the board to make it a strictly multiple system at any time, without any material extra cost or interruption of service. This made it possible to equip the plant with a full lamp signal central energy board at once.

Fig. 2 shows the main switchboard. The present equipment consists of four sections of three operators' positions each, with a multiple capacity in each section for multiplying the 2,400 lines.

The board is arranged for 120 lines per position. The switchboard, as originally installed, is arranged with a trunking system between the operators' positions. The lamp line signals and answering jacks are placed at the bottom of the face of the board. The trunking jacks and order keys are placed in each position immediately above the line signals. The board is designed and fully wired for changing and rigid. The supervisory and operator's set relays are mounted on an iron rack at the bottom of the switchboard frame. All working parts have every detail part made strong and durable and are mounted in a substantial manner and properly connected with No. 22 conductor, double silk, and single cotton insulated switchboard wire or cable.

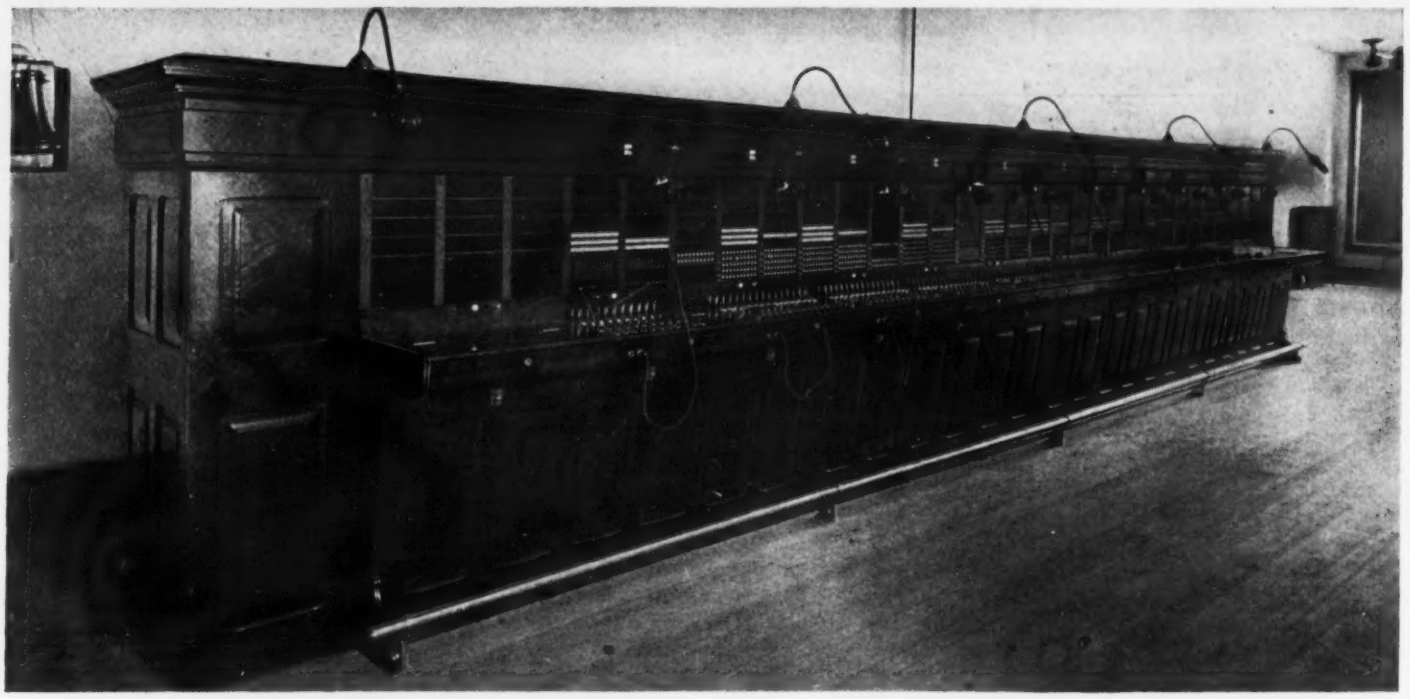


Fig. 2.—2,400-Line Capacity Lamp Signal Multiple Capacity Trunking Switchboard.

the system into a strictly multiple system by adding the necessary multiple jacks in each section and making the proper connection before cutting over the system. The multiple jacks are temporarily placed above the trunking equipment and are lowered into proper position after the system has been cut over and the trunking equipment removed. This change may be made without any interference with the service. The first position is equipped for 25 in-coming trunk or toll lines. Each operator's position is equipped with 15

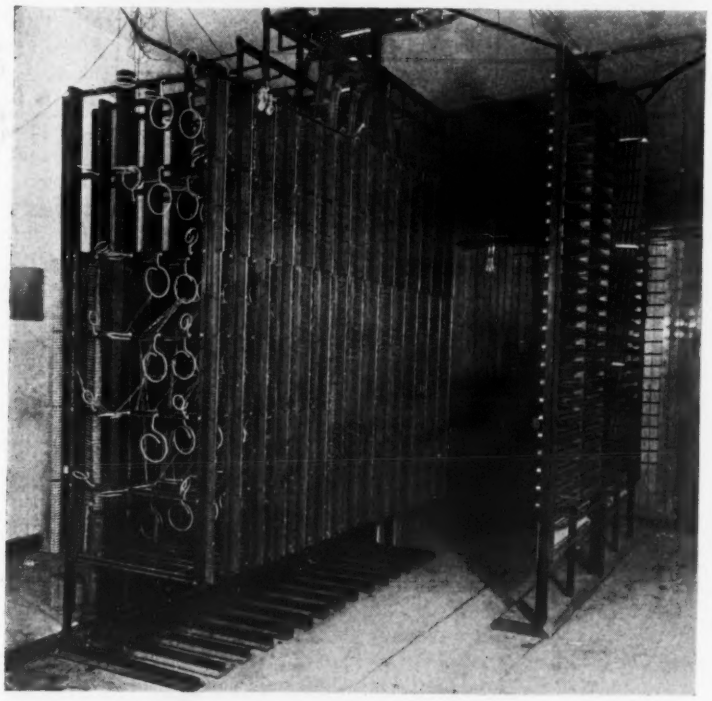


FIG. 3.—RELAY RACK AND MAIN AND INTERMEDIATE DISTRIBUTING BOARD.

pairs of connecting appliances with double supervisory clearing-out signals (party line keys), also a pilot lamp with line signals, one with the clearing-out signals and one with the ringing generator.

Fig. 1 is a rear view of the switchboard. The switchboard frame is of heavy architectural iron, well braced and made strong

Fig. 3 shows the terminal room. The lead-covered cables lead from the outside through the false floor to the rear of the distributing rack where they terminate in pot heads, at the bottom of the rack, and are properly connected with lightning arresters manufactured by the American Electric Fuse Company. These arresters are the new style Rolfe self-soldering heat coil and carbon protectors. The rack is a combination lightning arrester frame and intermediate distributing board, fully provided for complete multiple system. The relay rack is a large iron frame, built in two sections, each section accommodating the relays for 500 lines.

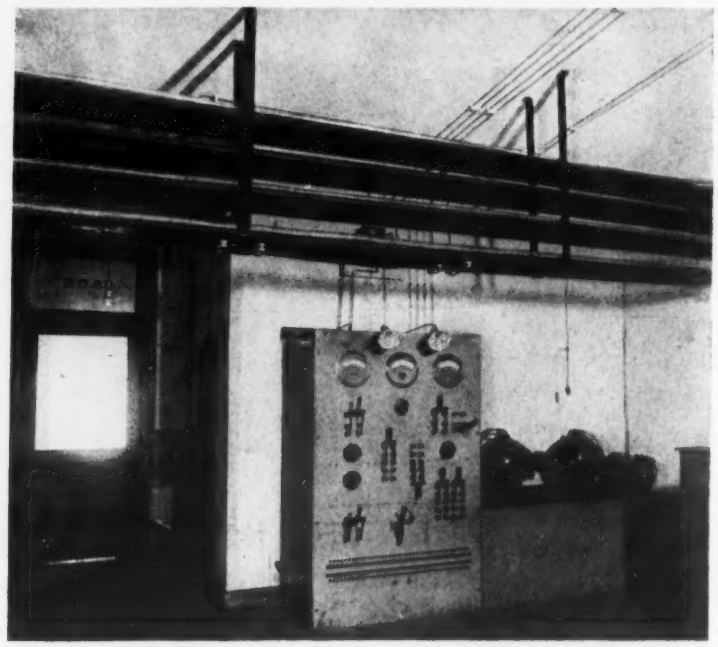


FIG. 4.—POWER EQUIPMENT.

Fig. 4 shows the power equipment. The power board is a heavy marble slab, fully equipped with Weston ammeters and voltmeter, voltmeter switch, proper knife switches for controlling the system, circuit-breaker, rheostat and starting boxes and the necessary bus-bars, etc. The Roth charging machine and ringing generators are

mounted on a strongly constructed table, provided with a hard wood top, supported by heavy soft rubber balls, to take up all vibration. The front of the table is provided with a heavy marble slab to correspond with the power board. The storage battery plant consists of 12 cells of metal tank chloride accumulators.

All parts of the equipment are provided for an ultimate capacity of 2,500 subscribers. The instruments used in the increase of the exchange and for part of the instruments replaced, are of the International long-distance central energy type.

Alternating Current Long Scale Voltmeter and Ammeter.

The accompanying cut shows an improved form of voltmeter and ammeter of the induction type, which in principle of operation is closely allied to the integrating wattmeter made by the same company, the Westinghouse Electric & Manufacturing Company. These instruments, simple in design, are made in the pattern shown in Fig. 2 and also in the more familiar circular form, Fig. 1.

The scales begin at zero, and the divisions are absolutely proportioned and uniform above 20 per cent. of the full capacity, with a length and openness which allows the readings to be made with perfect accuracy. As an additional aid to easy and correct reading from a distance, the dial of Fig. 2 is made of translucent material illumined from the rear, while the markings are distinct and the figures large and prominent. The lamps for illuminating this scale are enclosed in a compartment separate from the rest of the mechanism, giving perfect ventilation and not heating the working parts.

In this type an electromagnet produces a shifting magnetic field, in the air-gap of which is an aluminum disc in which currents are induced by the field, resulting in the disc's movement. This motion being opposed by a spring, the amount of deflection is shown by a pointer mounted on the shaft of the disc. When the pointer is at the zero position, the outline of the disc being spiral, the air-gap closes that portion of the disc having the longest radius. As the deflections increase the enclosed radii decrease, diminishing the

FIG. 1.—ALTERNATING-CURRENT AMMETER.

pull on the disc until it becomes proportional directly to the current, resulting in a uniform scale of great length.

These instruments are unaffected by external fields, are totally dead-beat, and are compensated for changes in temperature and frequency. The moving elements being very light in weight, the bearings of finely ground jewels and the shaft carefully hardened and polished, render friction a negligible quantity. They are made to certified and legal standards, with extremely careful calibration. The parts are interchangeable, and the cases dust-proof and of neat appearance.

Instead of requiring the main current to be brought to the instrument, necessitating in some cases expensive bus-bar connections, this make of ammeter is arranged to operate from 5-amp. secondaries

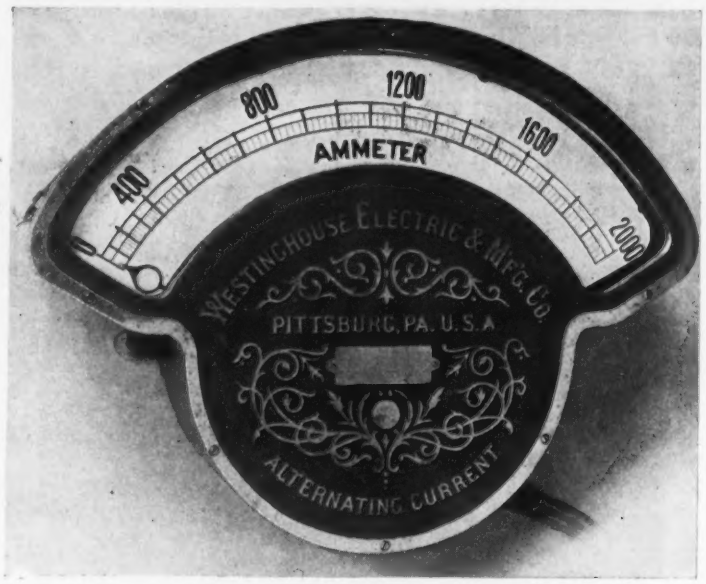


FIG. 2.—ALTERNATING-CURRENT AMMETER.

of series transformers, thus enabling the instrument to be mounted at any convenient point.

Power Transmission in Connecticut.

The New Milford Power Company, incorporated under the laws of the State of Connecticut with a capital of $1,000,000, mostly furnished by New Yorkers, is to build two large water power plants on the Housatonic River for the purpose of generating current for electric lighting, railway and manufacturing consumption in various parts of Connecticut. A 15-ft. dam is to be constructed across the Housatonic River at the head of Bull's Falls. A canal 11,000 ft. in length will convey the water to a large reservoir whence a 13-ft. steel flume will be built to one of the power houses to be located at Bull's Bridge. The working head will be 115 ft. The contract for the construction of the canal has been awarded to David Emanuel, of Catasauqua, Pa. The steel flume is to be built by the Riter-Conley Manufacturing Company, of Pittsburg, Pa. The Bull's Bridge plant will have an initial capacity of 6,000 kw. The equipment will consist of six 1,000-kw generators of General Electric build. They will be revolving-field, three-phase, 60-cycle machines to operate at 400 r.p.m. These generators will be direct-connected to special high-head turbines of 1,850-hp capacity each. The turbine contract has been secured by the Stilwell-Bierce & Smith-Vaile Company, of Dayton, Ohio. The machinery will generate at 1,150 volts and step up to 33,000 volts.

The other plant is to be situated at Gaylordsville, about four miles below the Bull's Bridge power house, with which it will be run in parallel. The capacity of the Gaylordsville plant will be 3,000 kw. The working head will be 33 ft. The contracts for the equipment have not yet been awarded. A double transmission line will be built almost straight across to Waterbury, a distance of 26 miles. At Waterbury, where the major portion of the power will be used, the Connecticut Railway & Lighting Company will construct a large receiving station for the distribution of power to operate its extensive railway, lighting and power interests. The station will take care of 6,000 kw and will be equipped with four 550-kw railway rotary converters and four 300-kw rotary converters for lighting use. The remainder will be utilized for arc lighting and general power purposes. All the rotary converters will be of six-phase, 60-cycle type, and will be of General Electric Company's manufacture. From Waterbury the transmission line will be continued to New Britain, 18 miles distant, by way of Southington. In the vicinity of Southington a transforming station will be built in which three General Electric six-phase, 60-cycle railway rotary converters will be installed for the purpose of operating the Meriden, Southington & Compounce Tramway Company and other lines con-

trolled by the Connecticut Railway & Lighting Company in the locality. At New Britain a station is to be built which will be equipped with three railway rotary converters, six-phase, 60-cycle, of 300-kw capacity each, of General Electric type, also similar machinery to handle 1,500 kw for light and power purposes. The transmission line will be built by the New Milford Company. The contracts for wire, etc., have not yet been determined. The company has the contract for supplying power to the Connecticut Railway & Lighting Company for a period of 30 years. The power is to be delivered at the step-down transformers at all the latter concern's plants. The contracts for the rotaries and other equipment for the transforming stations are let by the Connecticut company. Among those primarily interested in the New Milford Power Company are R. N. King, some time president of the Stilwell-Bierce & Smith-Vaile Company. Charles F. Cutler, president New York Telephone Company; J. W. Ogden, banker, 1 Nassau Street, New York; Chas. Sooy-Smith, 71 Broadway, New York, one of the consulting engineers of the Rapid Transit Commission; Nicholas Staub, ex-Controller of the State of Connecticut; W. S. Morton, electrical engineer, St. Paul, Minn., and H. R. Leyden, electrical engineer, formerly of Hamilton, Ontario. The New York offices of the company are in the Atlantic Building, 49 Wall Street.

Core Type Transformers.

The General Electric Company began the manufacture of the core type transformer in 1896 and since then continuous improvements have been made in all the features that go to make up a good transformer. Some of these are enumerated below. The great reductions made in losses during the last three years will be readily appreciated by referring to the curves of Fig. 1, which show the reductions in coreless and regulation from 1899 to 1902. On the various sizes the average percentage reduction in core loss is 11.7 per cent. and in regulation is 8 per cent. Since transformers are usually energized 24 hours a day, low core loss is, of course, of great importance in its effect on the all-day efficiency. Minimum core loss has been made one of the leading features of General Electric transformers, the core loss being as low as is consistent with proper insulation, low temperature and good regulation.

It is essential that the regulation of a transformer be as low as is consistent with good characteristics in other respects, as this admits

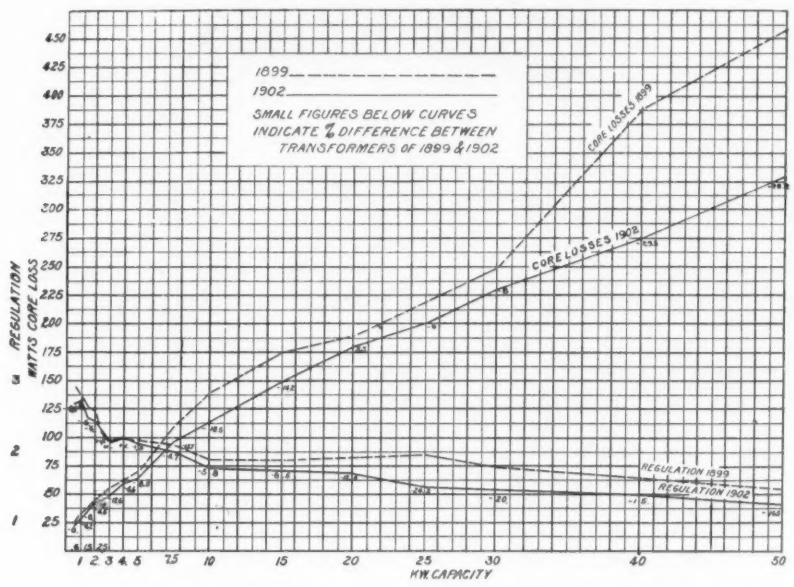


FIG. 1.—COMPARATIVE CURVES OF CORE LOSSES AND REGULATION.

of the use of high-efficiency lamps, insures low cost for lamp renewals, and makes possible a small variation in voltage between the peak and light loads on the station and consequent uniform light throughout the 24 hours.

Low uniform temperature is of importance in preserving the insulation and preventing deterioration of the iron which results in increase in core loss, commonly known as aging. The American Institute standard of 50° C. as the ultimate temperature rise for electrical apparatus has been adopted, as this is regarded by the most eminent engineers as a good safe figure. The ultimate temperature rise of the General Electric core type transformers will not exceed this amount, and because of the details of construction, the temperatures are uniform throughout. Every part of every coil has practically the same facility for passing off its heat.

Aging has been reduced to a minimum by the use of a specially-treated sheet steel and by processes of manufacture which have been developed in the course of 15 years' expeirence. Among the aids in regulating the properties of steel may be mentioned the

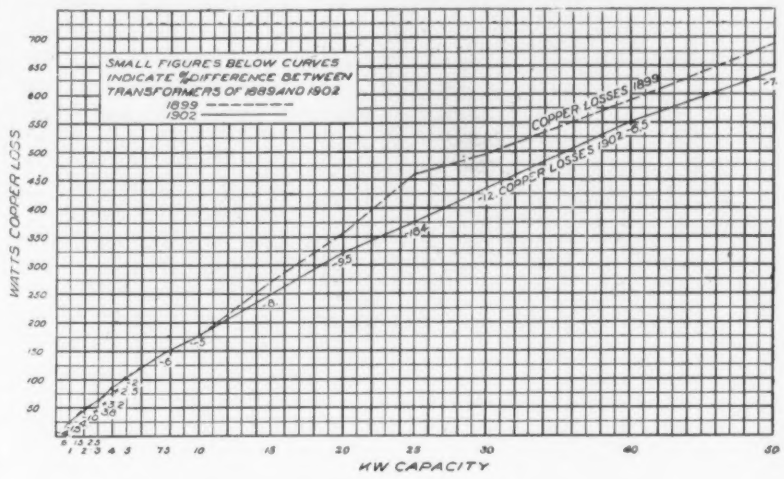


FIG. 2.—COMPARATIVE CURVES OF COPPER LOSSES.

microscopic examination of samples of steel. This method of investigation requires very skillful experts and a high grade of technical knowledge; but no expense has been spared to secure the best results. The effect of this work is shown by the result of a test which was made on 43 core type transformers taken indiscriminately from the lines of central stations. These were returned to the factory and were very carefully retested to show the amount of aging during their periods of operation. These transformers had been in service on an average for 2½ years, and showed the small average of 3.1 per cent.

Every transformer before shipment receives very careful tests as to its characteristics. An accurate record is kept of all these tests, so that at any time they can be readily compared with the result of subsequent tests.

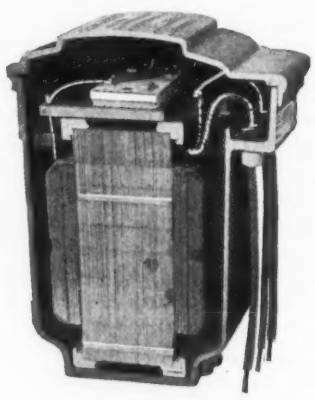


FIG. 3.—SECTIONAL VIEW OF TRANSFORMER.

FIG. 4.—MICA SHIELD.

Very careful attention is paid to the insulation which is used in these transformers. The method of manufacture of the various insulations used and methods of inspection employed, combined with the low uniform temperature maintained, have met with such success that during the last three years less than ⅓ of 1 per cent. of the total capacity of transformers sold have burned out from all causes, including lightning and overload. The percentage of

burn-outs due to lightning alone is two-tenths of 1 per cent. In this connection, particular attention is called to the mica insulation shield shown in Fig. 4. which is placed between the primary and secondary coils and renders a cross between primary and secondary practically impossible, thus giving security to the customer.

FIG. 5.—SPACES FOR OIL CIRCULATION.

The value of oil as a cooling and insulating medium has long been recognized, but this value is greatly reduced unless oil of the best properties is used. Although the oil used in the core type transformers is made especially for the purpose, has very high insulating qualities and is remarkable for its non-absorbent properties, it is subjected to very rigid inspection as to its characteristics and for the presence of moisture, and unless it passes this test satisfactorily, is rejected. The result is oil which gives the best results both as to cooling and insulation. Fig. 5 shows clearly spaces which are left for the circulation of oil in sizes of transformers constructed with cruciform cores.

This type of transformer is made in 16 sizes, from 600 watts to 50 kw inclusive, and in two lines, which, for convenience, are termed high and low-frequency lines. Both of these lines have the well-known characteristics of the core type design, and both give perfectly satisfactory operation on either 60 or 125 cycles. The distinctive difference between the two lines of transformers from an operating standpoint is in their data, the high-frequency transformers being slightly less efficient than the low-frequency, and having a correspondingly lower cost. For 60-cycle operation the high-frequency line may be used when extremely low efficiency is not of great importance. The transformers made for three-wire service have the winding so distributed that the voltage on the two sides of a three-wire system will not differ more than the regulation drop of the transformer even with one-half the rated capacity of the transformers all on one side; with ordinary distribution of load the voltage will be practically equal on the two sides.

Automatic Motor Starter.

The Automatic Switch Company, 131 Liberty Street, New York, has designed a modification of its belt-driven type of motor-starter, in which the pawl and ratchet of the latter are replaced by a magnetic clutch, which operates the resistance arm. This clutch is energized only at the time of cutting out resistance, and releases its hold on the resistance arm when the motor reaches full speed. By this construction wear on the starter is eliminated except the slight friction of the bronze worm while driving the idle clutch, and the arrangement produces an absolutely silent form of starter, which is a decided advantage for use in connection with high-grade elevator service.

Referring to Figs. 1 and 2, it will be seen that the circular clutch magnet on the face of the starter is driven from the pulley by a heavy three-pitch gear, meshing into a bronze worm, which is adapted to operate the starter arm at the proper speed, when driven at about 300 r.p.m. The clutch magnet-winding is connected in series with the small retaining magnet shown at the top of the resistance segments, and the current to both clutch magnet and retaining magnet passes through a suitable dead resistance. When the resistance arm comes in contact with the retaining magnet it short-circuits the clutch magnet coil and releases the worm gear from any further work, except the free revolution of the clutch. The resistance contacts are stamped from copper, and the starting current is fed to them through a heavy graphite brush while bringing the motor up to speed, and the running current is carried by a substantial laminated copper contact shown near the retaining magnet.

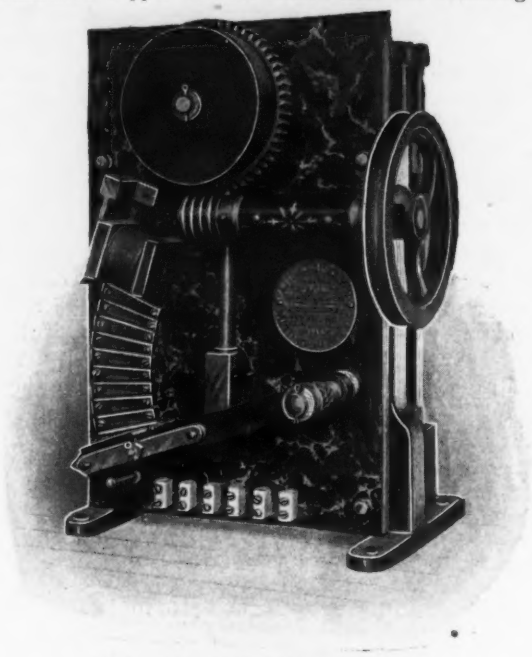


FIG. 1.—AUTOMATIC MOTOR STARTER.

The customary method of installing and driving the starter is shown in Fig. 2, but the position of the starter and switch may be varied to suit different conditions. The starters are adapted for connection

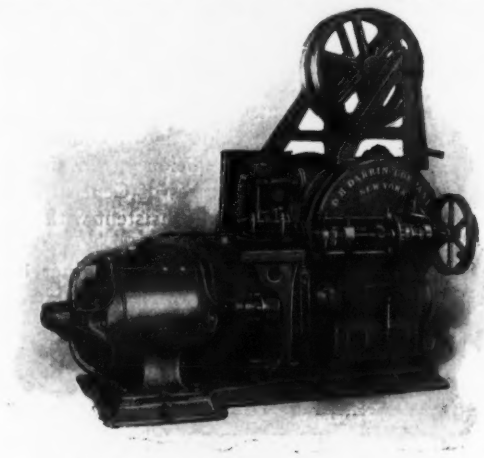


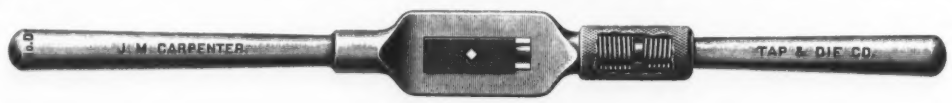
FIG. 2.—AUTOMATIC MOTOR STARTER.

to shunt, series and compound-wound motors, and to accommodate any desired number of series coils.

Tap and Reamer.

The wrench illustrated herewith is an improvement on the ordinary form of machinist's wrench. The knurled sleeve, broken away, shows a right-hand thread on the outside of the neck of the stock and a left-hand thread on the handle, the two threads engaging corresponding interior threads of the sleeve. A right-hand turn of the sleeve closes the jaws and a left-hand turn opens them. The handle thus moving in and out without rotating motion avoids all tendency to unscrew while at work.

The advantages claimed for this wrench are that no pin, wire or other implement is required to tighten the jaws upon the tap or reamer, and it possesses extra strength at the point where wrenches are usually the weakest. It is made by the J. M. Carpenter Tap & Die Company, Pawtucket, R. I.



TAP AND REAMER.

NEWS OF THE WEEK.

Financial Intelligence.

THE WEEK IN WALL STREET.—Money was easier and at the close of the week was liberally offered at lower rates, closing at 5 a 5¼ per cent. for all periods from 60 days to six months. The stock market showed greater strength as compared with the previous week, but towards the end relapsed into a condition of dullness. The trading was more professional, with manipulation in specialties and particular stocks. Toward the close on Friday there was a break in Metropolitan Street Railway and its affiliated stocks, the former declining from 132⅜ to 127. The movement was accompanied by further indefinite but adverse reports about the Metropolitan's finances. The United States Steel stocks sold down in the general market, and the new bonds were also weak in the outside market. Later on, however, they all showed a disposition to recover. Strike rumors affected Manhattan and caused a decline from 138 to 135¼. The stock was well supported, however, and rallied on Friday on rumors that the strike might not occur. Since that time the differences between the men and the company have been practically settled and the threatened strike seems to have been averted. The sales of Metropolitan aggregated 88,200 shares, the price ranging between 127 and 135¼, closing at 132, this being a net loss of 1½ points. Manhattan made a gain of 1 point, closing at 139. Brooklyn Rapid Transit ranged between 64⅛ and 67⅛, closing at 66½, a net loss of ⅜. General Electric showed some activity and made a net gain of 5½, closing at 190½, the lowest figure being 179 and the highest 192⅛. Westinghouse common closed at 193½, being ½ point above the last previous quotation, and first preferred at 202. Western Union was steady, closing at 85. Following are the closing quotations of April 21:

NEW YORK.

	Apr. 14.	Apr. 21		Apr. 14.	Apr. 21
American Tel. & Cable	..	80	General Electric	182⅛	192
American Tel. & Tel.	152	158	Hudson River Tel.	..	..
American Dist. Tel.	26	30	Metropolitan St. Ry.	133⅜	131¾
Brooklyn Rapid Transit	66	66⅜	N. E. Elec. Veh. Trns.	26	..
Commercial Cable.	..	..	N. Y. & N. J. Tel.	160	..
Electric Boat	23	20	N. Y. E. V. T. Co.	8	..
Electric Boat pfd.	35	35	Tel. & Tel. Co. Am	..	..
Electric Lead Reduction	1	1	Western Union Tel.	85½	85⅜
Electric Vehicle	10	12	Westinghouse com	185	206
Electric Vehicle pfd	14	16	Westinghouse pfd.	189⅛	206

BOSTON.

	Apr. 14.	Apr. 21		Apr. 14	Apr. 21
American Tel. & Tel	154⅛	159	Western Tel. & Tel. pfd.	95*	96¾
Cumberland Telephone	..	..	Mexican Telephone	1¾	1¾
Edison Elec. Illum.	..	..	New England Telephone	135	135
General Electric	181	..	Westinghouse	..	..
Western Tel. & Tel	19	20	Westinghouse pfd.	..	..

PHILADELPHIA.

	Apr. 14.	Apr 21		Apr. 14.	Apr. 21
American Railways	50	..	Phila. Traction	97	97⅜
Elec. Storage Battery	75*	70*	Phila. Electric	6⅞	7
Elec. Storage Battery pfd.	75*	70*	Pa. Electric Vehicle	..	..
Elec. Co. of America.	8⅝	9	Pa. Electric Vehicle pfd	..	..

CHICAGO.

	Apr. 14.	Apr. 21		Apr. 14.	Apr. 21
Central Union Tel.	..	..	National Carbon pfd.	97¼	97
Chicago Edison	..	..	Northwest Elev. com	..	..
Chicago City Ry.	205	..	Union Traction	7	7⅛
Chicago Tel. Co.	..	..	Union Traction pfd.	37	37
National Carbon	24⅛	24¼			

*Asked.

DENVER GAS AND ELECTRIC COMPANY.—At a meeting of the stockholders of the Denver Gas and Electric Company, held in the office of Emerson McMillan & Co., last Saturday, the resolution was passed: That the plan of re-adjustment of reorganization proposed by the protective committee of the stock and bondholders of the Denver Gas and Electric Company, dated November 10, 1902, be ratified and confirmed. Under this agreement the company will make payment to the holders of the consolidated bonds of their eighteen months' back interest in scrip, exchangeable in $1,000 denominations for new general mortgage bonds. Also to issue prior lien bonds 6 per cent.—15-year—to the amount of $1,000,000, and to issue present treasury stock to the amount of $500,000; and in addition, to place a new 5 per cent. general mortgage of $8,000,000 upon the property, of which $2,580,000 will be issued in exchange for the present $2,400,000 consolidated mortgage bonds with the additional $180,000 for back interest; $3,270,000 reserved in the hands of the trustee to retire the underlying bonds (inclusive of the $1,000,000 prior lien bonds) and $2,150,000 held in the treasury for future extensions and other uses of the company under proper restrictions.

WESTERN TELEPHONE.—The Western Telephone Company report states that on December 31, 1902, the number of subscribers of four of its sub-companies, the Northwestern, Southwestern, Cleveland and Wisconsin was 111,036. On December 31, 1899, the close of the last year reported by the Erie Company, the number of subscribers of these four companies was 74,327. The following comparison shows the subscribers and capitalization of the Western Telephone Company as of December 31, 1902, and of the Erie Company as of December 31, 1899:

	West. Tel.	Erie Tel.	West. Tel. Per subscriber.	Erie Tel. Per subscriber.
Subscribers	111,036	74,327	....	....
Bonded debt	$9,835,966	$12,739,403	$88	$171
Capital	32,000,000	10,000,000	288	134
Total capital	$41,835,966	$22,739,403	$376	$305

The total authorized capital stock of Erie Company was $15,000,000. Of this amount only $5,000,000 was outstanding in 1899, but as $5,000,000 more was issued shortly after the close of the year, Erie's capital stock is taken at $10,000,000.

Income accounts compare as follows:

	West. Tel.	Erie Tel.
Divs., etc., received	$1,304,209	$966,039
Expense and interest	630,360	482,761
Net earnings	673,849	483,278
Dividends	640,000	225,000
Surplus	33,849	268,278

Erie's dividends paid were 4½ per cent. on the $5,000,000 stock outstanding in 1899. The comparison favors Western Telephone still more since Erie received dividends from Michigan Telephone, and no item from that is included for Western Telephone. The dividends paid by Western Telephone are much larger than those of Erie in 1899, but this policy may be warranted by the stronger position of the former company as to earnings, capitalization and treasury assets.

GENERAL ELECTRIC REPORT.—As we go to press, the General Electric Company issues its annual report for the year ending January 31, 1903. The total sales (amount billed to customers) during the past year were $36,685,598. The yearly orders and sales for the past five years are as follows:

Year end. Jan. 31.	Amount billed.	Orders received.	Yearly increase of orders received.
1899	$15,679,430	$17,431,327	21.8%
1900	22,379,463	26,323,626	51.1%
1901	28,783,275	27,969,541	6.3%
1902	32,338,036	34,350,840	22.7%
1903	36,685,598	39,944,454	16.4%

Since February 1, 1900, the reported orders received have not included the items of services of experts and labor, freight and transportation, supply material, boilers, engines, etc., of outside manufacture and bare copper wire, which items were included prior to 1900. These items amounted to $1,558,371 during the past year. Including these items the total orders received for 1902 aggregate $41,502,825. The company has 3,000,000 square feet of factory floor space, and has 18,000 factory employees. The profits for the year less $44,331 interest on debentures were $10,232,837, but the company only paid out $2,677,263 in dividends.

DIVIDENDS.—The Lowell Electric Light Company has declared a dividend of $4, payable May 1, stockholders of record April 21. The directors of the American Light and Traction Company have declared the regular quarterly dividend of 1½ per cent. on the preferred stock, payable May 1. The directors of the Brooklyn City Railroad Company have declared the regular quarterly dividend of 2½ per cent. The Houghton County Electric Light Company will pay a dividend of 75 cents per share on the preferred stock (par $25) on May 1, to stockholders of record April 21. The Edison Electric Illuminating Company, of Brockton, will pay a dividend of $2.50 per share on May 1, to stockholders of record April 21.

STORAGE BATTERY STOCK.—Dispatches from Philadelphia announce that the stockholders of the Electric Storage Battery Company met and approved a proposition to permit holders of preferred stock to convert it into common, share for share. The preferred stock amounts to $4,500,000, all of which will probably be converted.

Commercial Intelligence.

THE WEEK IN TRADE.—Very satisfactory conditions exist generally, according to reports received by the mercantile agencies. The wet weather has retarded retail trade somewhat, but there is an improvement in collections nothwithstanding the bad weather. The agricultural outlook is of the best, and there is activity in farming work. Export trade is still expanding, cotton and corn being leaders, and manufactured products are also going abroad in larger volume. Iron production is surpassing all records, with improved transportation conditions and better supplies of coke. Finished products are in unprecedented demand, and foreign steel is arriving in increased volume to meet domestic needs. Despite widespread labor troubles, particularly in building lines, builders' hardware and structural steel are exceedingly active. Over-production is noted in very few lines of business, and manufacturers generally are pushed to keep up with orders. Premiums on quick delivery are disappearing, and imports of foreign iron are finding their field unrestricted. A feature in the more finished forms is the large demand for light rails for electric and street railways. Copper is slightly higher on the week, and other metals are steady. Copper advanced about ½ cent, nominally, through another arbitrary move of the large copper producers. The quotations are: 15 a 15¼c. for Lake and electrolytic; and 14½ to 14¾c. for casting stock. Railway earnings are the best ever recorded for this season, the gross receipts for March exceeding those of a year ago by about 14.5 per cent. The business failures for the week ending April 16, as reported by *Bradstreet's*, numbered 160 against 153 the week previous, and 193 the corresponding week last year.

BAY POWER, CAL., DEVELOPMENT.—Arrangements have been made at Oroville, Cal., to handle 350 carloads of freight for the Bay Power Company. This will be poles, wires and machinery for the plant on French Creek, twenty miles above Oroville. The company has had men working there for the past year and a half, preparing the grounds for a reservoir and dam. A tunnel is to be run three-quarters of a mile under the mountain to tap the little North Fork, and the waters of that stream will be added to those of French Creek. The surveyors of the Bay Power Company have just finished running a line from Sundale, six miles north of Oroville, to French Creek, on the east side of the North Fork. The object is to convey power and light to the big plant at French Creek. The company will send power from Centerville to be used in running the tunnel, working the derricks and lighting the place while this work is being carried on. When the plant is established, the same line will be used to transmit current from the new plant to towns and cities in the Sacramento Valley.

PUGET SOUND GENERATOR ORDER.—One of the very largest contracts for electrical generators ever placed for use west of the Rocky Mountains has been awarded by Stone & Webster, of Boston, managers of electric power, traction and lighting plants along Puget Sound, to the General Electric Company. It is for six machines, two to be furnished to the Tacoma Industrial Company, for use in its development of the White River, and four to the Pierce County Improvement Company for the work of developing the Puyallup River, including the flow from the Mount Rainier glaciers. The generators will be three-phase, 60-cycle, of 3,500 kw capacity each, at 2,300 volts and 225 revolutions. Deliveries will commence next September. Both of these developments are now being carried forward in accordance with the details that have been given of the work in these pages.

THE ELECTRIC STORAGE BATTERY COMPANY, of Philadelphia, manufacturer of the Chloride accumulator, has recently installed and has in process of installation a number of large batteries for railway work. Among these may be mentioned two batteries contracted for by the United Traction Company, of Albany, each having a capacity of 700 kw. These will be located at Albany and Troy, and operated in connection with specially-wound boosters for regulating fluctuations. The Cleveland, Painesville and Eastern Railway Company are to install, about June 1, a battery having a capacity of 460 kw. This battery is to be operated in connection with a motor-driven differential booster, and is designed to relieve the station of fluctuations, to care for peaks, and allow the plant to be operated with fewer generators than are now in service.

PUYALLUP RIVER POWER.—The Risdon Iron Works, of San Francisco, have secured a contract for the construction of four million pounds of steel pipe for the new water power plant building on the Puyallup River, near Tacoma, by the Pierce Company Improvement Company. The order was placed by General Manager S. Z. Mitchell. This is the largest order for pipe ever placed on the Pacific Coast. At its head the pipe line will be forty-eight inches in diameter. The first section will be 1,700 feet long, and in that space will have a drop of 877 feet. The diameter is gradually reduced until it becomes thirty-six inches at the bottom. The delivery of pipe is to be made between October 1 and February 15 next. The power company has 500 men clearing the right of way and building reservoirs above Lake Kapousin.

BULLOCK ELECTRIC GROWTH.—The Bullock Electric Manufacturing Company, of Norwood, Ohio, have recently occupied a new building of brick and steel, 177 feet wide by 300 feet long, for testing large work, and equipped with 50-ton cranes in center aisle, 75 feet span, and 30-ton cranes in side aisle. One machine worthy of notice is a pit lathe with a 44-ft swing. It anticipates lengthening this building another 300 feet. The company has now under construction one 5,000-hp a.c. and one 5,000-hp d.c. machines for the Cincinnati Gas and Electric Company; also several 12 2,000-hp to 3,500-hp, five of them for the Pittsburg Reduction Company, at Massena, N. Y., while others are for Pacific Coast work, as noted lately in this column.

ENGINE SALES.—Among the engine sales of the Allis-Chalmers Company, of Chicago, during the month of March, were the following: To the Carnegie Steel Company, Pittsburg, Pa., one 42 and 66 x 60 tandem roller-mill engine; South Side Elevated Railway Company, Chicago, Ill., one 34 and 70 x 54 1890 horizontal cross-compound Reynolds-Corliss engine; Illinois Steel Company, Chicago, Ill., two 46 and 66 x 84 and 84 x 60 vertical steeple cross-compound blowing engines; the International Traction Company of New Jersey, Jersey City, two 34 and 68 x 48 1890 cross-compound condensing Reynolds-Corliss engines; the Pennsylvania Railroad Company, one cross-compound Reidler air compressor 15 and 24 x 36.

THE SAN FRANCISCO & SAN JOAQUIN COAL COMPANY, of San Francisco, has decided to install machinery for the briquetting of coal dust, the high price of coal in California rendering this profitable. The briquetting presses will be driven by electric motors arranged to give any desired speed from 20 r.p.m. to 550 r.p.m. in about 15 steps. Two 40-hp, slow-speed, 500-volt, direct-current motors have recently been purchased for this purpose from the Westinghouse Electric & Manufacturing Company, together with speed-controlling rheostats designed to vary the speed of the motors within the above limits. The controllers will allow the motors to be operated continuously at any of the speeds.

EQUIPMENT FOR WINCHESTER (IND.) TRACTION PLANT.—The Union City, Winchester and Muncie Traction Company is now letting contracts for the equipment of its new power station, at Winchester, Ind. The engine contract has been awarded to the Buckeye Engine Company, of Salem, Ohio. It calls for two 21 in. and 42 in. by 48 in. compound direct-connected engines, and a similar number of exciter engines to operate at 200 pounds pressure. The generators and exciters will be General Electric.

EQUIPMENT FOR BIG CLEVELAND DEPARTMENT STORE.—The Westinghouse Electric and Manufacturing Company has secured the contract for the generators to be installed in the big department store and office building now under construction at Cleveland by J. Hartness Brown, Jr., of that Ohio city. The generators will be direct-connected to 11½ in. and 19 in. by 14 in., 15 in. and 25 in. by 18 in., and 20½ in. and 34 in. by 27 in. compound engines, of Buckeye build.

POWER HOUSE AT PAINESVILLE, O.—Contracts for the erection of a power house at Painesville, Ohio, for the Cleveland Painesville and Ashtabula Railway Company, of Cleveland, have been placed. The power equipment will include 900-hp Sterling water-tube boilers, two 600-hp compound condensing engines, to be built by the C. & G. Cooper Manufacturing Company, and two 360-kw alternating-current generators, etc., furnished by the General Electric Company.

MANUFACTURING ELECTRIC VEHICLES.—The Baker Motor Vehicle Company, of Cleveland, manufacturers of light electric vehicles, is to erect a large factory. It is preparing plans for a power plant and is securing estimates on a 250-hp cross compound engine, to be direct connected to a 150-kw alternating current generator. The Corlett Engineering Company is the engineer for the work.

EQUIPMENT FOR A. S. & W. NEW MACHINE SHOPS.—The American Steel and Wire Company's new machine shops, to be built at Worcester, Mass., will be equipped with three 20 in. and 38 in. by 30 in. Buckeye compound direct-connected engines. A 14¼ in. and 28½ in. by 21 in. engine has also been ordered. The generators will be Westinghouse.

THE STANLEY ELECTRIC MANUFACTURING COMPANY has sold thirty-two 38-hp and twenty 50-hp street railway motors to the Sheboygan Light, Power and Railway Company, of Sheboygan, Wis. A sale has also recently been made of a 750-kw engine type railway generator to the Trenton Street Railway Company.

GREAT FALLS, MONT.—The Boston and Great Falls Electric Company, of Great Falls, Mont., is now installing one 360-kw Westinghouse revolving field two-phase alternator 2,200 volts, and one 675-hp Victor turbine of the Stilwell-Bierce & Smith-Vaile Company's make. W. D. Dickinson is the manager of the plant.

GENERAL SPECIFICATIONS FOR THE CONSTRUCTION OF TELEPHONE AERIAL LINES.

NOTE.—The construction of aerial lines is rarely performed by contract, as each telephone company usually builds its own lines. For this reason no form of contract is embraced in the *"Specifications for Aerial Line Construction."* If contract work is desired, the form of contract used, for either conduit or cable construction, can with slight modification be employed.

SECTION 1.

1 General Characteristics

Aerial lines shall be embraced in three types:

"A"—Bracket Lines.
"B"—Cross Arm Lines.
"C"—Aerial Cable Lines.

"A"—BRACKET LINES. Bracklet lines are those of small capacity, in which the circuits are carried on brackets placed on the side of the poles to which they are attached. Lines of this type shall be limited in capacity to six wires, three being placed upon each side of each pole.

"B"—CROSS ARM LINES. Cross arm lines are those using cross arms for the support of the circuits. The maximum capacity of cross arm lines shall be limited to ten arms of ten pins each; thus, the maximum capacity of a cross arm line is one hundred wires.

"C"—AERIAL CABLE LINES. Aerial cable lines shall be those which use dry core paper cables, suspended by messenger strands to the poles. The number of aerial cables shall be limited to four, and the maximum size of each cable one hundred and fifty pair.

SECTION 2.

2 Routes

Prior to commencing construction, a careful examination and general survey of all desirable routes shall be made. From this survey a sketch map shall be prepared for the use of the right-of-way agent. A sample of such sketch map is shown in Fig. 1. This shall indicate the route which it is considered, on the whole, most desirable to follow, and the approximate desired location of all poles, guy stubs, etc. Wherever it is feasible to select more than one location, all of the desirable locations shall be indicated, in order that the right-of-way agent may have alternative routes in securing permits. No construction shall be commenced until rights of way have been finally and formally secured by the authorized right-of-way agent, in definite written form, upon the approved blanks of the company.

SECTION 3.

3 Location

Aerial lines shall be located only on permanent rights of way. These rights of way shall include the necessary permission to erect all poles and guy stubs, to string necessary wires, and trim such trees and shrubbery as may be required to secure the proper working of the circuits. Rights of way shall be secured by the right-of-way agent, and shall be in accordance with all of the laws of the country traversed, and in conformity to all municipal regulations of all towns or villages traversed. The right-of-way contracts shall be examined and approved by the General Council of the company prior to the commencement of construction.

SECTION 4.

4 General Instructions to Foremen

1.—WORK TO BE DONE ACCORDING TO RIGHT-OF-WAY CONTRACT.

Prior to commencement of any construction, each foreman shall be supplied with a blue-print map, showing the location of all rights of way, and copies of contracts with all property owners. The maps and contracts shall be sufficiently explicit so that the location for every pole, guys, guy stub, or other attachment, and the permission to string wires and trim trees and shrubbery, shall be so specifically described that foremen shall have no difficulty in proceeding with construction in exact acordance with each permission received. Foremen shall be responsible to see that all poles, anchors, guy stubs, or other attachments, are placed in exact accordance with the contracts, and that the erection of wires, and trimming of trees and shrubbery, is done as the permissions specify.

2. OBJECTIONS.

In case any person shall offer any objections to the prosecution of any part of the work that seems to be clearly within the obtained permissions, or shall endeavor to hinder the erection of any poles, guy stubs, wires or other attachments, or the trimming of any trees or shrubbery, the foreman shall courteously call the attention of such objecter to the copies of the contract permissions which he holds. In case the objection is still persisted in, the foreman shall stop work on the portion of the line in question, and shall refer this objection at once to the General Manager or Superintendent, and wait for further instructions. All foremen shall be rigidly responsible to perform all operations exclusively within the written contracts of rights of way. Foremen must under all circumstances take particular pains that no contract is exceeded in any single particular, and they must be responsible to treat, and to see that all employees reporting to them, do treat all persons with the greatest politeness and courtesy, and that all work of construction is so prosecuted as to interfere with, damage, or inconvenience all persons in the smallest amount.

3. ACCIDENTS.

During the prosecution of all work herein called for, foremen shall conduct all operations with all possible care for the safety and security of the general public, that of all of their employees, and of all property. Foremen shall not assume any risks whatsoever of any nature, or description, not absolutely entailed by the nature and character of the work under construction. During the raising of poles, the stringing of wire, or the erection of cables, particular pains shall be taken to secure the public from injury. Poles, wire and cable shall not be raised during the passage of teams or pedestrians, without giving due warning by stationing a watchman, with a red flag, at both ends of the portion of the highway occupied, and no work shall be done in such a manner as

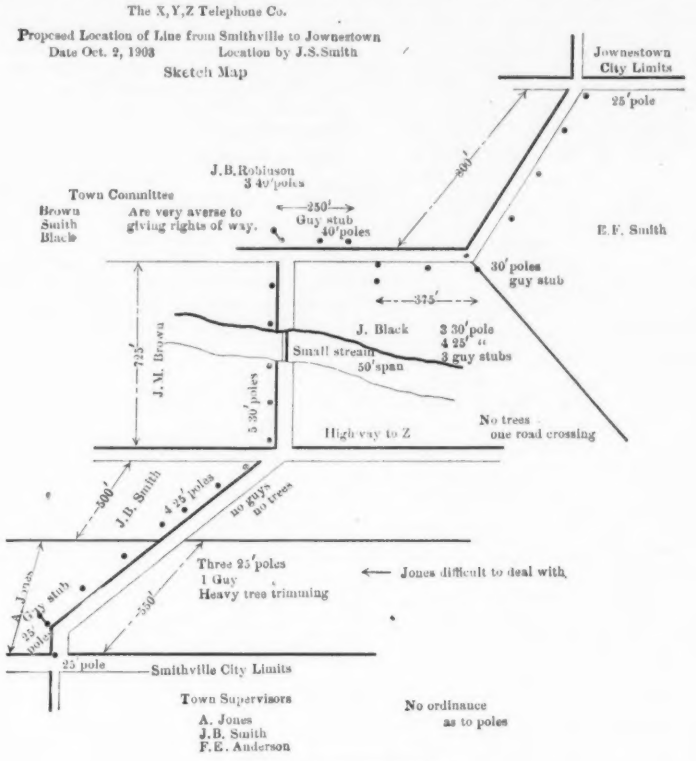


FIG. 1.—SKETCH MAP.

to endanger the safety or convenience of those using the highway, more than is absolutely necessary. All material shall be so distributed along the highway as to produce a minimum of inconvenience to the public, and shall be arranged in such a manner as not to become a source of danger. In all cases where material sensibly obstructs the highway, a lighted red lantern shall be placed as a warning each evening at sunset. Each lantern shall be capable of burning all night. As fast as construction is completed, all surplus material and tools or debris of whatsoever nature, shall be removed and the highway left in its normal and proper condition.

In all operations in any way connected with the work herein specified, foremen shall carefully observe and comply with all of the laws of the land, and with all municipal rules, ordinances or regulations of the towns traversed that shall in any way affect the conduct of those employed, or the method of doing work specified, or in the use of any materials, tools, appliances or machines. Particular pains shall be taken not to interfere with, or trespass in any respect upon the rights of way of any railway, telephone or telegraph company, whether such rights of way are upon the ground, or in the air, and in all cases foremen shall confine all operations strictly within the written rights of way contracts with which they are supplied.

In case of any accident, that can in any way be attributable to the prosecution of the work herein specified, the foreman shall immediately take the following steps:

"A"—ACCIDENTS TO PERSONS.

First.—Dispatch a messenger immediately for the nearest physician, and report the occurrence to the police if within corporate limits.

Second.—Take all possible local steps that will in any way conduce to the comfort of the injured.

Third.—As soon as practical make a written report to the company upon authorized blanks, stating the names and addresses of all injured, the nature and cause of the injury, the names and address of the attending physician, and of any or all witnesses of the accident.

"B"—ACCIDENTS TO PROPERTY.

First.—Take all possible local steps that shall prevent any extension of damage, and that shall in any way protect the property injured, and notify the police if within corporate limits.

Second.—Notify all owners that may be unaware of the occurrence of the character and probable amount of injury, and that a report will at once be sent to the company who will take immediate, proper action thereon.

Third.—Forward accident report to the company as under "A"—3.

SECTION 5.

5 Inspection

All classes of material called for under these specifications shall be subject to inspection by an authorized inspector, duly appointed by the company. The company shall have liberty to select as the place of inspection, either the point of manufacture or shipment, or the point of delivery specified by the company of each class of goods. A reasonable number, or amount of samples of each kind of goods herein called for, shall be supplied to the inspector for the purpose of making such examinations as are herein called for. Any and all material which does not entirely fulfill the requirements of the specifications, all and singular, shall be rejected by the inspector. If any goods shall be rejected which the company elects to inspect at the point of delivery, the company shall notify the vendor as soon as the inspector completes the examination thereof, and, as soon as the notification is sent of the rejection of any goods, the vendor shall remove the same, and after such notification the company shall be no longer responsible in any way, shape or manner for the care or preservation of such rejected articles, and the vendor shall, under no circumstances, institute against the company any claim for injury or damage to such goods.

SECTION 6.

6 Shipments

Each of the various kinds of goods herein specified shall be properly and suitably packed for shipment by the vendor. The packing shall in all cases be such as is adequate to protect and guard each of the several classes of goods from the ordinary contingencies of transportation, and to enable them to be delivered to the company in proper order without loss or damage, or injury in any respect. Each individual package, box or bale, shall be properly and plainly marked with the name of the company, the destination to which the goods are to be forwarded, and the route they are to pursue, together with a statement and description of the kind of article, and number of pieces which each package is to contain. The vendor in all cases shall properly deliver the goods to the transportation company by which they are to be forwarded, and shall take the customary freight receipt and bill of lading, and shall forward to the company suitable evidence of proper shipment. In all cases the responsibility of the company for goods shall not commence until after the company shall have received them from the transportation company in good order, and in no case shall any vendor advance any claim for damages against the company until the company shall have received in good order the goods in question from the transportation company.

SECTION 7.

7 General Qualifications of Iron and Steel

All articles made of iron or steel under these specifications, except wire, shall be made of a first-class quality of wrought iron, or preferably of mild steel. The quality of the metal used shall in all cases be equal to that employed in bridge or structural iron work. All wrought iron shall have a tensil strength of not less than fifty thousand pounds per square inch of area, an elastic limit of not less than twenty-five thousand pounds per square inch, shall elongate not less than 15 per cent in a test piece of eight inches in length, and shall have a reduction in area of not less than 25 per cent. All mild steel shall have an ultimate strength of not less than fifty-five thousand pounds per square inch, an elastic limit of not less than thirty-two thousand pounds per square inch, an elongation of not less than 28 per cent in eight inches, and a reduction of area of not less than 45 per cent.

The fracture of wrought iron test pieces shall be fibrous, with not over 25 per cent of white or granular spots. The fracture of mild steel shall be cup shaped and silky, and absolutely homogeneous in texture. All pieces of wrought iron or steel shall be capable of being bent, cold 180 degrees, around a mandrel having a diameter not to exceed their least thickness.

SECTION 8.

8 Galvanizing

All iron and steel used in building open wire lines shall be galvanized, unless *distinctly specified* to the *contrary*, and all galvanizing for each specific case, shall be done in such a manner as to stand the following test:

From each shipment of each kind of goods, the inspector shall select such a reasonable number of samples as shall, in his judgment, fairly represent the consignment in question. Each sample shall be immersed in a saturated solution of sulphate of copper for one minute. At the expiration of this minute it shall be removed and wiped dry. This process shall be repeated four times. If after the fourth immersion and wiping any deposit of copper can be found upon the sample, or if any red spots can be detected, or if the galvanizing shall be seen to be corroded and removed, it shall be considered defective, and the goods represented by this sample shall be rejected. All galvanizing shall be smooth and clean. There shall be no superfluous spelter or drops of zinc, or rough places, or other imperfections. All holes, grooves, recesses and threads shall be entirely clean and free from zinc, and shall be fully up to the dimensions required of them, and in all cases galvanizing shall be so performed that the parts intended to fit together can be readily and easily assembled.

SECTION 9.

9 Material Specifications

The bulk of material required for the construction of aerial lines is comprised within the following schedule:

TABLE I.

SCHEDULE OF OPEN WIRE LINE MATERIAL.

Section 10—Poles.
Section 11—Creosoted Poles.
Section 12—Guy Stubs and Anchor Logs.
Section 13—Wooden Pole Braces.
Section 14—Brackets.
Section 15—Cross Arms.
Section 16—Pins.
Section 17—Insulators.
Section 18—Cross Arm Braces.
Section 19—Cross Arm Bolts.
Section 20—Carriage Bolts.
Section 21—Fetter Drive Screws.
Section 22—Double Arm Bolts.
Section 23—Pole Steps.
Section 24—Pole Rings.
Section 25—Pole Protection Strips.
Section 26—Pole Wheel Guards.
Section 27—Guy Rods.
Section 28—Guy Strands.
Section 29—Thimbles.
Section 30—Strand Clamps.
Section 31—Rock Eye-bolts.
Section 32—Staples.
Section 33—Fuses.
Section 34—Ground Rods.
Section 35—Connectors.
Section 36—Copper Line Wire.
Section 37—Iron Line Wire.
Section 38—Bridle Wire.
Section 39—Weather Proof Wire.
Section 40—Tie Wire.

SECTION 10.

10 Poles

All poles shall be of the best quality of live green timber, free from rot, sound and substantial in every respect. The grain of every pole shall be close and hard, with the annular rings closely pitched, and the heart sound and firm. Every pole shall be straight and well-grown, free from all objectionable bends. Each pole shall contain the natural butt of the tree, squarely sawn with no trimming to reduce size. Poles shall vary in length by increments of five feet from twenty to seventy feet, and shall have an approximately uniformly decreasing cross section from butt to top; shall be true and well-proportioned, and shall be cut and felled between the first of November and the first of March. From each pole all the bark and soft wood shall be carefully removed, all knots trimmed closely and smoothly, and the butts squared. The top of each pole shall be roofed and such a number of grains for cross arms cut in each pole as may be specifically directed for the pole in question. The first gain shall be cut ten inches from the top of the pole, and each subsequent gain shall be 24 in. below the preceding one. Each gain for standard cross arms shall be 4¼ ins. wide, and ⅛ in. deep; for light cross arms the gain shall be 3¾ ins. wide, and ½ in. deep. All gains shall be cut true and square with the axis of the pole, smoothly and evenly, in such a manner that all cross arms shall accurately fit the gains, and shall stand at right angles with the pole in all directions. Each gain shall be bored with two $^{9}/_{16}$ in. holes for two ½ in. bolts, or with $^{11}/_{16}$ in. hole for one ⅝ in. bolt, as may be directed. If two bolts are specified, the holes shall be spaced 1½ ins. on each side of the center of the gain. If one bolt be specified, the hole shall be bored directly through the center of the pole, all holes shall be at right angles to the gain and at the axis of the pole. The general appearance of all poles and pole tops shall be as in Figs. 2 and 3. Each pole shall be sound, strong, and free from objectionable cracks, rot or other defects, and shall be subject to inspection either at the point of shipment, or at the point of delivery, as the company may elect, and all poles which do not strictly conform to all requirements of the specifications shall be unqualifiedly rejected.

The sizes and dimensions of poles, and the price per pole of various dimensions, shall be in accordance with Table II.

TABLE II.

POLE DATA.

Circumference in inches.

Length feet. in	At top.	6 ft. from butt.	Price per pole.	Approximate weight. each.	Approximate No. per car.
20	12½	24	(To be filled in at time of purchase.)	100 pounds	200 1 car
20	16	25		130 pounds	175 1 car
25	12½	24		150 pounds	150 1 car
25	16	25		200 pounds	120 1 car
25	17½	26		250 pounds	110 1 car
25	19	27		350 pounds	100 1 car
25	22	30		350 pounds	100 1 car
25	25	34		275 pounds	100 1 car
30	19	30		275 pounds	100 1 car
30	22	34		350 pounds	100 1 car
30	25	37		450 pounds	80 1 car
35	22	37		450 pounds	120 2 cars
35	25	40		600 pounds	110 2 cars
40	22	40		625 pounds	100 2 cars
40	25	43		800 pounds	90 2 cars
45	22	43		835 pounds	82 2 cars
45	25	46		1,000 pounds	60 2 cars
50	22	46		1,035 pounds	40 2 cars
50	25	50		1,250 pounds	25 2 cars
55	22	50		1,300 pounds	30 2 cars
55	25	54		1,550 pounds	25 2 cars
60	22	54		2,000 pounds	20 2 cars
60	25	58		2,000 pounds	20 2 cars
65	25	58		2,700 pounds	15 2 cars
70	22	64		3,400 pounds	12 2 cars

SECTION 11.

11 Creosoted Poles

The process of creosoting poles and cross arms shall be in accordance with the following requirements. Prior to treating, all mill work shall be done, and all holes bored, so that subsequent to the completion of the preservative process there shall be no cutting of timber. Creosoting shall be done by placing the lumber to be treated in a closed tank and steaming it with steam at a pressure of not less than forty-five pounds gauge, for a period of not less than four hours. At the end of the steaming a vacuum of not less than twenty inches of mercury shall be applied to the tank, and all drainage from the timber pumped away. The vacuum shall be continued so long as there is any sensible discharge of sap or moisture from the timber. Pure dead oil of tar shall be then pumped into the tank, and an hydraulic pressure shall be applied sufficient to force into the timber at least twelve pounds of oil per cubic foot of timber treated. The absorption of oil by the timber shall be determined by measuring the total quantity of oil pumped into the tank, and comparing this with the known volume of the timber and the known volume of the tank. All oil used shall be pure dead oil of tar, and, if required, shall be subjected to a chemical analysis, and shall possess the following characteristics: It shall be liquid at 100° Fahr. It shall contain at least 25 per cent. of constituents that do not volatilize at a temperature of 600° Fahr. It shall not contain over 5 per cent. of tar acids. It shall contain no admixture of any substance not derived from the distillation of coal tar.

After the process of creosoting is completed, all timber shall be stacked at least six inches away from the ground, shall be so piled as to permit a free circulation of air around all pieces, and shall be allowed to season in this manner for not less than three months prior to being used.

Prior to setting, the butts of all *untreated* poles, guy stubs and anchor logs shall be charred and tarred. Each pole shall be placed on a skid and slowly revolved over a hot fire until the entire butt, to about one foot above where the ground surface will intersect the pole, is thoroughly charred. While hot the butt shall be thoroughly painted with melted first-class coal tar, rubbed into the charging with a stiff brush.

SECTION 12.

12 Guy Stubs and Anchor Logs

The timber used for guy stubs and anchor logs shall correspond in all respects with the specifications for poles, and shall be creosoted whenever creosoted poles are employed. Anchor logs shall not be less than twenty-five inches in circumference at the smallest point, and shall be at least four feet in length.

Guy stubs shall not be less than twenty-two inches in circumference at the smallest end, and of such a length as shall enable the stub to extend six feet into the earth, and at the same time support the top of the guy at such a point as may be required above the ground. Untreated guy stubs and anchor logs shall be tarred as specified in Section 11.

SECTION 13.

13 Wooden Pole Braces

The timber to be used for wood pole braces shall fall under the same specifications as given for poles. No pole brace shall be less than eighteen inches in circumference at the smallest end, and of such length as may enable the brace to be set six feet in the ground, and to extend to the proper point required for supporting the pole. At the point at which the brace is attached the pole shall not be mortised more than three-fourths of an inch, but the brace shall be trimmed to fit the pole. Wherever creosoted poles are used, pole braces shall be creosoted; if untreated they shall be tarred as specified in Section 11.

SECTION 14.

14 Brackets

Brackets shall be of two kinds:

"A"—Wood Brackets.

"B"—Iron Brackets.

"A"—WOODEN BRACKETS. Wooden brackets shall be of the general form and dimensions as shown in Fig. 4. They shall be made of the best quality of oak; sound and perfect in every respect; fully up to the dimensions specified; neatly and carefully machined, with the bolt holes accurately spaced, carefully bored with sharp tools and with the insulator thread perfectly and truly cut, and a good fit for standard telephone insulators.

"B"—IRON BRACKETS. Where more than two wires are to be placed on one pole, an iron bracket shall be used. There shall be two styles of iron brackets, namely, two-pin and four-pin brackets, as shown in Fig. 5. The bracket strip shall be of a first-class quality of flat-iron, or steel, to which the pins shall be solidly and substantially attached, as shown, and the pins shall in all respects correspond to the specifications for wooden pins—Section 16—otherwise iron brackets shall have the form and dimensions of Fig. 5.

SECTION 15.

15 Cross Arms

There shall be four kinds of cross arms:

"A"—Standard Arms.

"B"—Light Arms.

"C"—Alley Arms.

"D"—Cable Arms.

"A"—STANDARD CROSS ARMS. All cross arms, except cable arms, shall be made of thoroughly seasoned, straight-grained wood—either Norway pine or Southern pine, as may be directed. The timber used shall be free from sap wood, and from any knots which may weaken it. Every arm shall be solid, sound and substantial, free from bad cracks, dry rot, or any other imperfections whatsoever, shall be smoothly and accurately milled, with all dimensions full, as hereinafter specified. All holes shall be bored of the sizes specified, and at right angles to the respective faces of the cross arms, true and straight, and with sharp tools to avoid tearing or injuring the wood. All sides of every cross arm shall be straight and true, and at right angles to each other, and without warp or wind. Cross arms ordered creosoted shall be treated as specified in Section 11. In case cross arms are not treated, each arm shall be thoroughly painted with a brush, and given two coats of Prince's metallic paint, color red, mixed in the ratio of two pounds of dry paint to one gallon of linseed oil. A drawing of the standard ten pin cross is shown in Fig. 6. The dimensions for standard cross arms, containing less than ten pins, shall be as in Table III.

TABLE III.

STANDARD CROSS ARMS.

Finished size, 3¼ in. x 4¼ in.

* Bored for 1½ in. or 1¼ in. pins, two ⅜ in. carriage bolts and one ⅝ in. or two ½ in. bolts, as may be directed.

Length.	No. pins.	Pin Spacing. Ends.	Sides.	Centers.	Approximate weight.
3 ft.	2	4 in.		28 in.	10 lbs.
4 ft.	4	4 in.	12 in.	16 in.	14 lbs.
5 ft.	4	4 in.	15 in.	22 in.	17 lbs.
6 ft.	4	4 in.	21 in.	22 in.	21 lbs.
6 ft.	6	4 in.	12 in.	16 in.	21 lbs.
8 ft.	6	4 in.	16½ in.	22 in.	28 lbs.
8 ft.	8	4 in.	12 in.	16 in.	28 lbs.
8½ ft.	10	3 in.	10 in.	16 in.	29¾ lbs.
10 ft.	8	4 in.	15 in.	22 in.	35 lbs.
10 ft.	10	4 in.	12 in.	16 in.	35 lbs.
10 ft.	12	4 in.	9⅗ in.	16 in.	35 lbs.

"B"—LIGHT CROSS ARMS. For light lines or those which are to be erected in particularly protected and inexposed situations, it is permissible to use a slightly lighter arm. The dimensions for light cross arms shall be as in Table IV.

"C"—ALLEY CROSS ARMS. Where pole lines are erected in alleys, a special arm is required, as it is usually impossible to center the arm upon the pole, but it must be placed as shown in Fig. 7. This requires that the square portion of the arm, fitting the gain, shall be in the center between the second and third pin holes from the end of the arm; that the holes for the arm braces shall be bored between the first and second pins, and the fourth and fifth pins, and that a special hole $^{9}/_{16}$ in. in diameter, for a vertical brace, shall be bored between the seventh and eighth pin on each arm, as shown in Fig. 7. In other respects the dimensions of the arm, of the pin holes, and bolt holes, shall be as already specified for standard arms. Arms for terminal poles or corners and all exposed locations shall be bored for 1½ in. insulator pins. Cross arms to be used with iron pins shall have all pin holes bored for ⅝ in. bolts, driving fit, but in all other respects shall have the same dimensions as above specified.

"D"—CABLE CROSS ARMS. The cross arms for supporting aerial cable shall be made of angle iron. Each arm shall be fitted to receive four cables,

* Pin holes shall be a driving fit; carriage bolt holes $^{7}/_{16}$ in. diameter; ½ in. machine bolt holes $^{9}/_{16}$ in. diameter; ⅝ in. machine bolt holes $^{11}/_{16}$ in. diameter.

FIG. 2.—POLE ELEVATION.

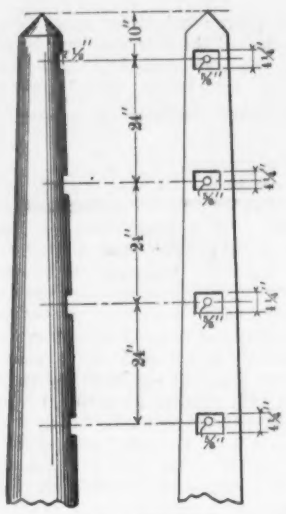


FIG. 3.—POLE TOP.

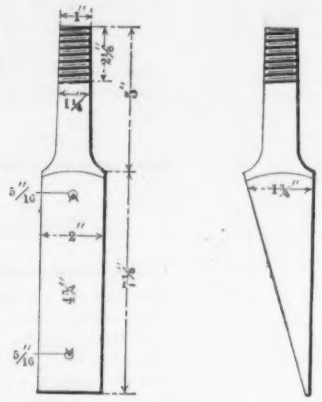


FIG. 4.—WOOD BRACKET.

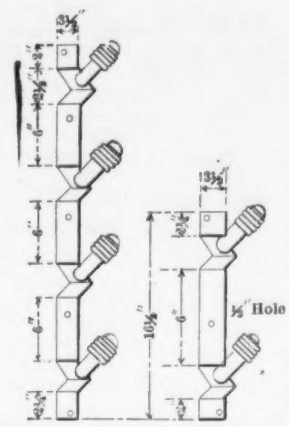


FIG. 5.—IRON BRACKETS.

FIG. 6.—YELLOW PINE CROSS ARMS.

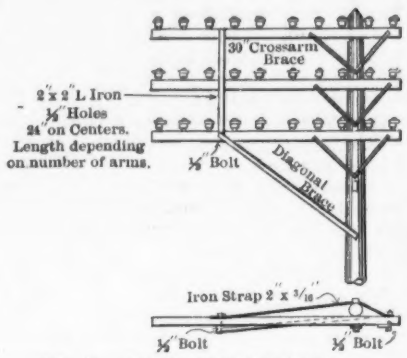


FIG. 7.—ALLEY ARM LOCATION.

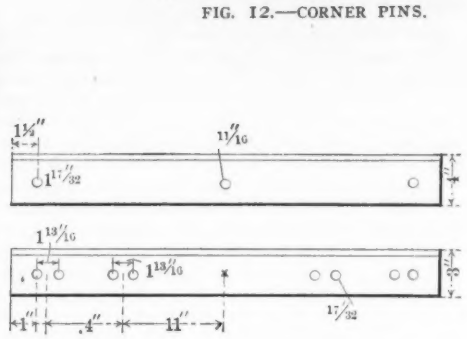


FIG. 9.—CABLE CROSS ARM.

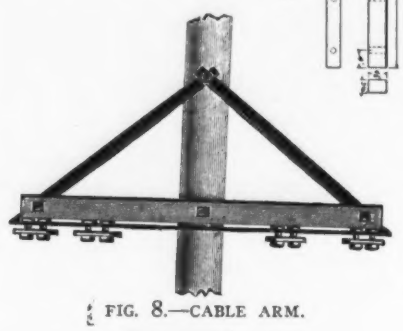


FIG. 8.—CABLE ARM.

FIG. 12.—CORNER PINS.

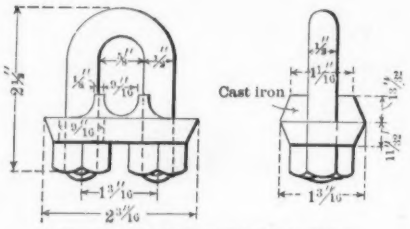


FIG. 10.—CABLE STRAND U-BOLT.

FIG. 13.—IRON PINS.

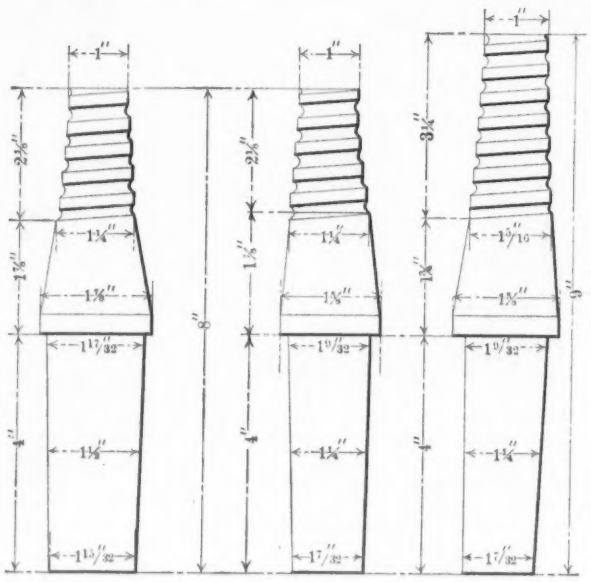
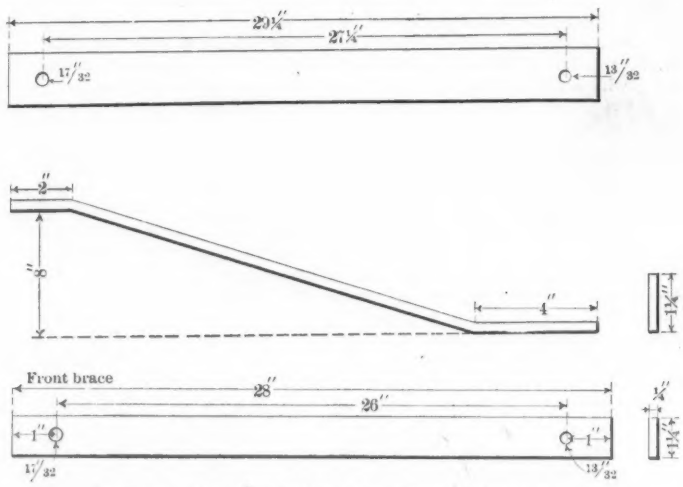


FIG. 11.—WOODEN PINS.



FIGS. 15 AND 16.—BACK AND FRONT CROSS ARM.

CONSTRUCTION AND EQUIPMENT OF AERIAL TELEPHONE LINES.

and shall be attached to the pole one foot below the lowest open wire arm, as shown in Fig. 8. Cable arms shall consist of a piece of angle iron, weighing not less than twelve pounds to the foot, thirty-six inches in length,—shown in detail in Fig. 9. The angle shall have a 11/16 in. hole bored in the center thereof, for the purpose of attaching the same to the pole. On either side of the center, respectively at eleven inches and fifteen inches away from the center,

TABLE IV.

LIGHT CROSS ARMS.

Finished size, 2¾ in. x 3¾ in. (See note preceding page.)

Arms bored for 1¼ in. pins, two ⅝ in. carriage bolts, and one ⅝ in. or two ½ in. bolts, as may be directed.

Length.	No. pins.	Pin Spacing—Ends.	Pin Spacing—Sides.	Pin Spacing—Centers.	Approximate weight.
24 in.	2	3 in.		18 in.	5 lbs.
30 in.	2	3 in.		24 in.	7 lbs.
42 in.	4	3 in.	10 in.	16 in.	9½ lbs.
62 in.	6	3 in.	10 in.	16 in.	14 lbs.
82 in.	8	3 in.	10 in.	16 in.	18 lbs.
102 in.	10	3 in.	10 in.	16 in.	23½ lbs.
4 ft.	4	3 in.	13 in.	16 in.	11 lbs.
6 ft.	6	3 in.	12½ in.	16 in.	16½ lbs.
8 ft.	8	3 in.	12½ in.	16 in.	22 lbs.
10 ft.	12	3 in.	10 in.	14 in.	27½ lbs.

the fixtures for supporting the aerial cables shall be placed, which shall consist of steel U-bolts, as shown in Fig. 10. At a distance of 1½ ins. from each end of the cross arm, a 17/32 in. hole shall be bored for the purpose of attaching the cross arm brace. Each cross arm shall be furnished with four steel U-bolts, as shown in detail in Fig. 10.

(NOTE.—For additional specifications for aerial cable lines see Specifications for Aerial Cables.)

SECTION 16.

16 Pins

There shall be two kinds of pins:
1—Wooden Pins.
2—Iron Pins.

1.—WOODEN PINS.

There shall be three kinds of wooden pins, respectively known as (A) Line Pines, (B) Transportation Pins, and (C) Terminal Pins.

"A"—LINE PINS. The general form and dimensions of the Line Pin is as shown at A—Fig 11. The shank shall be four inches long, and have an average diameter of 1¼ ins., being 19/32 ins. under the shoulder, and 17/32 ins. at the bottom of pin. The insulator thread shall be 2⅛ ins. long, 1 in. in diameter at bottom, with a pitch of four threads per inch, and shall fit a standard Pony insulator. In all respects the Line Pin shall correspond to the dimensions of Fig. 11.

"B"—TRANSPOSITION PINS. The transposition pin shall be of the form and have the dimensions shown in Fig. 11—B. It shall differ from the Line Pin only in having the insulator thread 3¼ ins. long instead of 2⅛ ins.

"C"—TERMINAL PINS. The Terminal Pin shall be of the form and have the dimensions shown in Fig. 11—C. It shall differ from the line pin only in the diameter of the shank, which shall be 117/32 ins. under the shoulder, 115/32 ins. at the bottom of the pin, and average 1½ ins. In particularly exposed locations the shank of Terminal Pins shall be supplied with an iron bolt, nut and washer, as shown in Fig. 12. This bolt shall be ¼ in. in diameter, 1½ ins. long outside the pin shank, and shall be secured in the shank firmly and solidly. The thread of the bolt and the nut shall be U. S. standard. The washer shall be ⅛ in. thick, 3 ins. in diameter, and closely fit the bolt. All pins shall be made of the very best quality of thoroughly seasoned locust wood, sound, clear, free from knots and sap wood, subsequently boiled in paraffin or oil. All pins shall be cut of exactly the dimensions specified in Fig. 11 in all respects. They shall be solid, substantial, free from all cracks, shakes, soft wood or other defects, and shall be machined with sharp tools, smooth and fully up to all the dimensions specified.

2.—IRON PINS. The general style and method of making iron pins is shown in Figs. 13—"A" and "B". Each pin shall consist of an iron or steel bolt, not less than ⅝ in. in diameter, supplied with a U. S. standard thread, nut and washer. The thread shall be at least 1¼ ins. long. The bolt shall be securely fastened into a cap, made of locust wood, which in all respects shall conform to all the requirements and match all the dimensions, specified in "A" and "B" of this section, for wooden pins. There shall be two sizes of wood caps—one with an insulator thread 2⅛ ins. long, to correspond to the line pin, and one 3¼ ins. long, to correspond to the transposition pin. The distance between the shoulder of the iron pin, and the inner face of the washer, when the nut is so screwed on the bolt as to allow two full threads to project outside of the nut, shall not be less than 4 ins.

SECTION 17.

17 Insulators

1—GLASS INSULATORS. Insulators shall be of two kinds: "A"—Line Insulators, "B"—Transposition Insulators.

"A"—Line Insulators. Line insulators shall be used for ordinary line work, and shall be of the type known the trade as the "Standard Pony" insulator. The general form of the Pony Insulator is illustrated in Fig. 14—A, and a section and dimensions are given in Fig. 14—B.

"B"—Transposition Insulators. The transposition insulators shall only be used where transpositions are to be made. There are four varieties of transposition insulators on the market, either one of which will answer the purpose, and are illustrated in Figs. 14—C, D, E and F, standing in the same order of excellency. At G a section, with dimensions of F, is given, and that portion of all transposition insulators which receives the pin shall have the dimensions of Fig. 14—G. All insulators shall be made of standard white or green glass—which shall not decompose under the weather—carefully and accurately finished with smooth surfaces, free from cracks, seams, flaws, sand spots, flat places, or any other imperfections whatsoever. They shall be moulded full and true, and shall show a minimum die-seam. Screw threads shall be carefully and accurately moulded, and shall be free from fins or sharp edges, and shall accurately fit the threads of the standard pins.

2.—PORCELAIN INSULATORS. Insulators may be made of porcelain, the porcelain line Pony being shown at Fig. 14—H. Porcelain is somewhat stronger than glass, is a little less likely to crack in handling, and has somewhat better insulating characteristics, so is preferable on these accounts. The porcelain insulators shall be made of a first-class quality of highly glazed, brown porcelain, and shall in all respects possess all of the characteristics specified for glass insulators. Porcelain insulators shall be fully and thoroughly glazed; and hard burnt, and the enamel shall show no cracks, and shall be insoluble in any of the mineral acids.

SECTION 18.

18 Cross Arm Braces

There shall be three kinds of cross arm braces, made of iron or mild steel:
"A"—Front Braces.
"B"—Rear Braces.
"C"—Alley Arm Braces.

"A"—Front Braces. Front Braces are those which shall be placed on the same side of the pole as the cross arm. Front braces are shown in Fig. 15. They shall be made of flat iron, 28 ins. long, 1¼ ins. wide, ¼ in. thick, and shall have one 17/32 in. hole drilled 1 in. from one end, and one hole 13/32 in., drilled 1 in. from the other end.

Braces for cable arms shall have belt holes drilled 17/32 in. in diameter.

"B"—Rear Braces. Rear braces are those which shall be placed on the opposite side of the pole from the cross arm. Rear braces are shown in Fig. 16. They shall be made of flat iron, 1¼ ins. wide, ¼ in. thick, 29¼ ins. long, and shall have one hole 17/32 in., drilled 1 in. from one end, and one hole 13/32 in., drilled 1 in. from the other end. Each rear brace shall have an offset, as shown in Fig. 16.

"C"—Alley Arm Braces.

1.—*Vertical Brace.* The vertical alley arm brace is shown in Fig. 17—A. It shall consist of a piece of 2½ in. x 2½ in. angle, weighing 2½ lbs. per foot. One inch from each end of the brace a hole 13/32 in. in diameter shall be drilled. The length of this brace will depend on the number of cross arms for which it is to be used, and an allowance of 24 ins. in length for each arm shall be made, and for each arm one hole 13/32 in. shall be drilled, as shown.

2.—*Diagonal Alley Arm Brace.* The diagonal alley arm brace, Fig. 17—B, shall be 38 ins. long over all, and shall be made of a piece of 2½ in. x 2½ in. angle, 2½ lbs. per foot. For a space of 4 ins. on each end, the flange of the angle shall be removed. One inch from one end a hole 17/32 in. in diameter shall be drilled, and one inch from the other end a hole 13/32 in. in diameter.

SECTION 19.

19 Cross Arm Bolts

Cross arm bolts shall be of steel, and supplied in two sizes, ½ in. and ⅝ in. in diameter, and of each size there shall be five lengths of bolts, measured under the head, respectively, 12 ins., 13 ins., 15 ins., 18 ins. and 20 ins. long. Each bolt shall have a thread 4 ins. long, cut on its end, supplied with a nut and square washer. All threads and nuts shall be U. S. standard. Fig. 18 shows the details of the ⅝ in. bolt and washer. The ½ in. bolt and washer shall be the same in all respects, except that the diameter of the bolt shall be ½ in., and that of the hole in the washer 17/32.

SECTION 20.

20 Carriage Bolts

All carriage bolts shall be standard trade iron carriage bolts, ⅜ in. in diameter, 4½ ins. long under head, and having a nut and washer as shown in Fig. 19.

SECTION 21.

21 Fetter Drive Screws or Lag Bolts

All fetter drive screws shall be standard trade fetter bolts, made of iron, ½ in. in diameter, and 5 ins. long over all. They shall correspond to the dimensions of Fig. 20.

SECTION 22.

22 Double Arm Bolts

Double arm bolts shall be made of ½ in. steel rod. There shall be four sizes, respectively, 17 ins., 20 ins., 23 ins. and 26 ins. over all. On each end of each bolt a U. S. standard thread shall be cut for 12 ins. Each bolt shall be supplied with four U. S. standard nuts, threaded to fit the bolt, and four steel washers, ¼ in. thick, and 2½

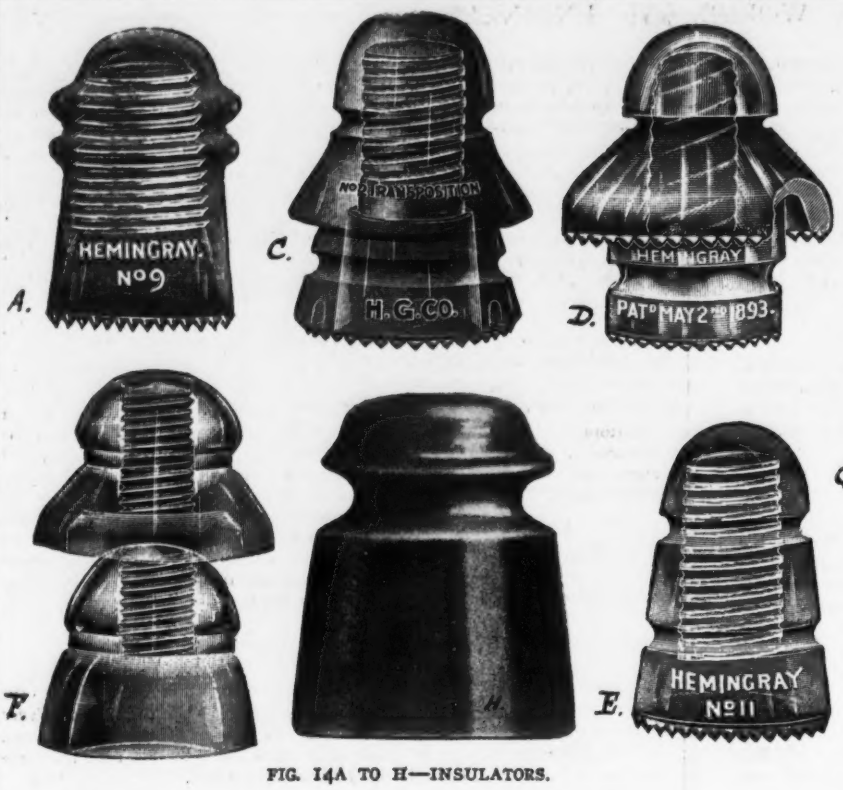
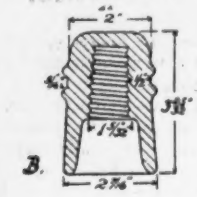


FIG. 14A TO H—INSULATORS.



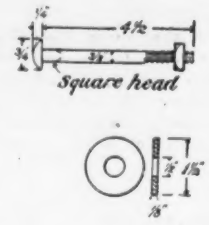
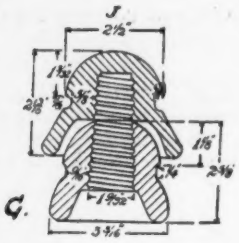


FIG. 19.—CARRIAGE BOLT.



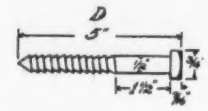


FIG. 20.—DRIVE SCREW OR LAG BOLT.

FIG. 22.—POLE STEP.

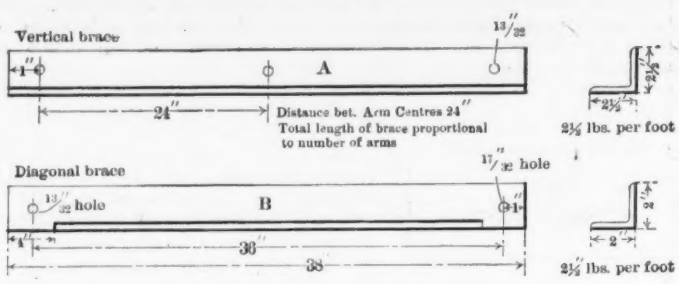


FIG. 17.—ALLEY ARM BRACES.

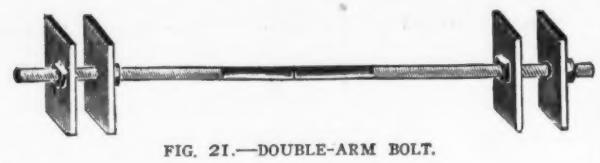


FIG. 21.—DOUBLE-ARM BOLT.

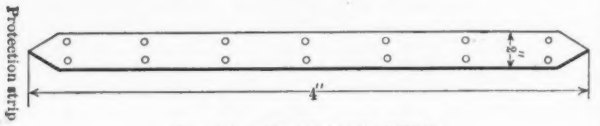


FIG. 24.—PROTECTION STRIP.

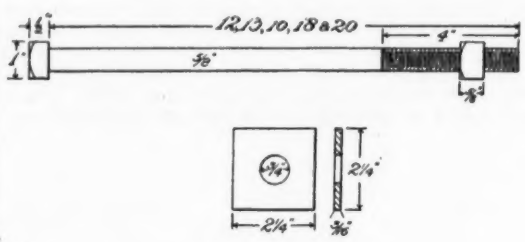


FIG. 18.—CROSS ARM BOLTS.

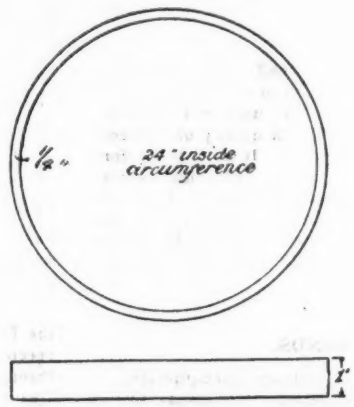


FIG. 23.—POLE RINGS.

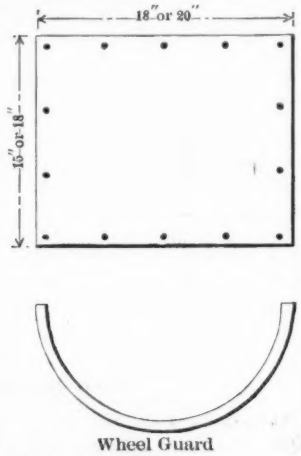


FIG. 25.—WHEEL GUARD.

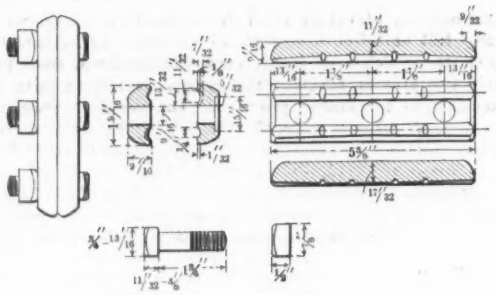


FIG. 28C.—STRAND CLAMP.

FIGS. 28A AND 28B.—STRAND CLAMP.

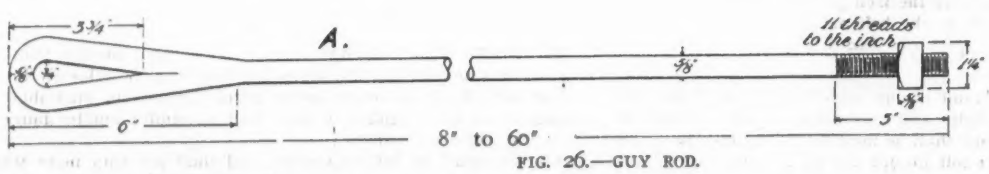


FIG. 26.—GUY ROD.

ins. square, each drilled with one $^{37}/_{32}$ in. hole in the center. The double arm bolt is shown in Fig. 21, and each bolt shall be shipped assembled in accordance therewith.

SECTION 23.

23 Pole Steps

Pole steps shall be of steel, as shown in Fig. 22, ⅝ in. diameter, 10 ins. long over all, turned up for 1½ ins. at the end, and provided with a lag bolt thread for 3 ins. on the end.

SECTION 24.

24 Pole Rings

Pole rings shall be of iron or mild steel. They shall be 24 ins. in circumference inside, 1 in. wide, ¼ in. thick, made of ¼ in. by 1 in. bar, and otherwise according to Fig. 23.

SECTION 25.

25 Pole Protection Strips

Protection strips are shown in Fig. 24, and shall be made of sheet iron or steel, not less than 18 B. & S. gauge, 2 ins, wide, by 24 ins. long, and shall be punched with fourteen holes for tenpenny wire nails. All strips shall be concaved longitudinally to approximately fit the pole.

SECTION 26.

26 Wheel Guards

Wheel guards are shown in Fig. 25. They shall be made of $^{5}/_{16}$ in. iron or steel plate, of two sizes, respectively, 15 ins. x 18 ins., and 18 ins. x 20 ins., and shall be bent to a radius of 7 ins. Each plate shall be punched with fourteen holes, ¼ in. in diameter, or for twentypenny nails.

SECTION 27.

27 Guy Rods

Guy rods shall be made of wrought iron or mild steel. They shall be ⅝ in. in diameter, 18 ins. to 60 ins. by increments of 6 ins. long over all, furnished with an eye welded at one end, and a U. S. standard thread, and nut at the other end, and shall be of the dimensions and according to Fig. 26—A. Each guy rod shall be supplied with one iron washer of the style and dimensions shown by Fig. 26—B.

SECTION 28.

28 Guy Strands

All guys, from the end of the guy rod to the pole, shall be made of a first-class quality of wire rope. The wire used in making guy strands shall be the best quality of Bessemer or Sieman-Martin steel. It shall be uniform in quality, of an even cylindrical section, free from all die marks, scales, splits, flaws or other imperfections. Each wire shall be double galvanized. Every strand shall contain at least seven wires, and in case wires are spliced the tensil strength of the strand shall not be reduced thereby. All strands shall have the physical characteristics given in Table 5.

TABLE V.

PROPERTIES OF GUY STRANDS.

Diameter in inches of Wire.	Strand.	Lay in inches.	Ultimate strength—lbs. Bessemer.	Sieman-Martin.
.072	¼	3	2500	3050
.109	$^{5}/_{16}$	3½	4200	4860
.120	⅜	3¾	5700	6800
.134	$^{7}/_{16}$	4	7600	7000
.165	½	4½	9800	11000

SECTION 29.

29 Thimbles

Thimbles shall be made of wrought iron or mild steel, and shall correspond in all respects to the form and dimensions of Fig. 27.

SECTION 30.

30 Strand Clamps

Strand clamps shall be of two sizes; the two-bolt and three-bolt clamp. Two-bolt clamps shall be used for ¼ in. strands only; three-bolt clamps for all strands over ¼ in. The general appearance of strand clamps is shown in Fig. 28A and B, detail dimensions of a three-bolt clamp at C, to which all three-bolt clamps shall correspond. Two-bolt clamps may be proportionately smaller. The clamp grooves shall accurately match the strand specified in Section 28. All clamps shall be of the best quality of malleable iron or soft steel casting. The bolts shall be special steel, having a breaking strength of not less than 80,000 pounds per square inch. All castings shall be smooth, fully formed and carefully finished.

SECTION 31.

31 Rock Eye Bolts

Eye bolts for rock guying shall be of the style, dimensions and construction, as shown in Fig. 29. The sides shall be made of the best quality of commercial wrought iron or mild steel. Bolts shall be steel and shall have a breaking strength of not less than 70,000 pounds per square inch. Bolts for rock guying shall be made accurately to the dimensions shown, shall be carefully finished and shall correspond to all dimensions given. Rock eye bolts shall be assembled and wired together in sets, and then shipped either in boxes, barrels or bags.

SECTION 32.

32 Staples

Staples shall be made of galvanized wire, approximately No. 6 B. W. G. They shall be 2⅛ ins., and otherwise of the style and dimensions as shown in Fig. 30. All staples shall be galvanized, and shall be packed and shipped in boxes.

SECTION 33.

33 Fuses

Line fuses shall be of the general style shown in Fig. 31. Clamps shall be capable of being attached to any wire between Nos. 5 and 12 B. & S., as shall be specified. Fuses shall blow at three, five or seven amperes, as may be specified in each case, and each fuse shall be plainly marked with its capacity. The fuse gap shall be not less than 3 ins. The fuse case shall be of waterproof material, and each terminal provided with lock nuts.

SECTION 34.

34 Ground Rods

Ground rods shall consist of ½ in. steel or iron rods, 6 ins. long. Each rod shall have one end drawn to a point, and the other cut suqare. One inch (1 in.) from end that is squared, a $^{3}/_{16}$ in. hole shall be drilled through the rod perpendicular to its axis.

SECTION 35.

35 Connectors

Connectors shall be made of copper, and designed according to Fig. 32. Each connector shall be not less than 1¼ ins. long, and provided with two bolts, each not less than ¼ in. in diameter. Each bolt shall have a lock nut or other approved method of securing the nut. Connectors shall be designed for wire from No. 5 to 12 B. & S.

SECTION 36.

36 Copper Line Wire

All copper line wire shall be hard drawn. It shall be cylindrical in section, uniform in quality, with smooth surface, free from all die marks, scales, splints, flaws, fractory joints or other imperfections of whatsoever nature. The inspection of all wire shall be done at the factory of the manufacturer, who shall at all times afford the authorized inspector of the company full and free access to all processes of manufacture through which the wire, to be delivered under these specifications, shall pass. The manufacturer shall also provide adequate testing machines for making any and all of the mechancial tests hereinafter provided. The inspector shall have the privilege of inspecting all of raw material from which the wire is made. The inspector shall cut a sufficient length from each end of each coil of wire to make all of the mechanical tests hereinafter specified. Each coil of wire shall be drawn from one bar in one continuous length, and shall be free from all joints or splices. The diameter of the eye of each coil shall not be less than 20 ins. or more than 22 ins. When shipped, each coil shall be bound with four lashings of twine, and shall be so protected by burlap that there may be no danger of mechanical injury during transportation. Each coil shall be plainly and indelibly marked by two tags, one of which shall be attached inside of the burlap, and the other on the outside. These tags shall state the weight and length of the coil in question. The mechanical and electrical properties of hard drawn copper wire shall be as in Table VI:

All samples of hard drawn copper shall elongate not less than 1 per cent. or more than 2 per cent. in test pieces five feet long. Samples of No. 5 hard drawn copper wire, 6 ins. in length, when tested for torsion, shall show not less than twenty twists in a length of 6 ins. Each successive smaller gauge shall show at least five additional twists.

All wire shall be full in section, and shall not vary more than .001 in. on either side of the diameters specified in Table VI., and the weights per mile of wire shall not vary more than 3½ per cent. on either side of the weights specified in Table VI. The conductivity of all wire shall be at least 97 per cent. of Matthieson's standard.

TABLE VI.

PROPERTIES OF HARD DRAWN COPPER WIRE.

Numbers B. & S. gauge.	Diameters in mils.	Areas in circular mils.	Weights per 1000 ft.	Weights per Mile.	Resistances in internation ohms at 68°F. Per 1000 ft.	Resistances in internation ohms at 68°F. Per mile.	Tensile strength—lbs.
5	182.	33102.	100.	529.	.3199	1.689	1550
6	162.	26251.	79.	419.	.4033	2.130	1235
7	144.	20818.	63.	332.	.5085	2.685	980
8	128.	16510.	50.	264.	.6413	3.386	778
9	114.	13093.	40.	209.	.8088	4.277	617
10	102.	10383.	32.	166.	1.0199	5.384	489
11	91.	8234.	25.	132.	1.2854	6.787	388
12	81.	6529.	20.	104.	1.6218	8.563	307
13	72.	5178.	15.7	83.	2.0443	10.794	244
14	64.	4106.	14.4	76.	2.5779	13.612	193
15	57.	3257.	9.9	52.	3.251	17.165	153
16	51.	2582.	7.8	41.	4.099	21.646	133
17	45.	2048.	6.2	33.	5.055	27.694	97
18	40.	1624.	4.9	21.6	6.518	34.416	77

SECTION 37.

37 Galvanized Iron Wire

Iron wire shall in all qualifications, regarding size, finish method of manufacture, inspection, etc., correspond to the specifications in Section 36, given for copper wire. There shall be three kinds of iron wire, respectively known as E.B., B.B.B. and Steel. The properties of the various kinds of wire are given in Table VII.

Samples of iron wire shall elongate not less than 15 per cent. in lengths of one foot, and when tested for torsion there shall be at least fifteen twists in pieces 6 ins. long. All wire shall be thoroughly and carefully annealed and double galvanized.

TABLE VII.

PROPERTIES OF GALVANIZED IRON WIRE.

Numbers B. W. G.	Diameters in mils.	Weights, lb., per 1000 ft.	Weights, lb., per Mile.	Breaking strengths, lbs. Iron.	Breaking strengths, lbs. Steel.	Resistance per mile in ohms. E. B. B.	Resistance per mile in ohms. B. B.	Resistance per mile in ohms. Steel.
2	284	212	1121	3363	6335	4.19	4.91	5.8
3	259	177	932	2796	5268	5.04	5.9	6.97
4	238	149	787	2361	4449	5.97	6.99	8.26
5	220	127	673	2019	3801	6.99	8.18	9.66
6	203	109	573	1719	3237	8.21	9.6	11.35
7	180	85	450	1350	2545	10.44	12.21	14.43
8	165	72	378	1134	2138	12.42	14.53	17.18
9	148	58	305	915	1720	15.44	18.06	21.35
10	134	47	250	750	1410	18.83	22.04	26.04
11	120	38	200	600	1131	23.48	27.48	32.47
12	109	31	165	495	933	28.46	33.3	39.36
13	95	24	125	375	709	37.47	43.85	51.82
14	83	18	96	288	541	49.08	57.44	67.88

SECTION 38.

38 Bridle Wire

Bridle wire shall be of No. 19 B. & S. gauge (36 mils in diameter), copper, insulated with okonite. The wire shall be first tinned, and then thoroughly and uniformly covered with rubber compound to a thickness of $^{8}/_{32}$ in. The composition shall be homogeneous in composition, and shall be evenly applied to a uniform thickness, and concentrically with the wire, and shall have the following electrical properties: After forty-eight hours immersion in water at a temperature of 60° Fahr., all wire shall show an insulation resistance of not less than 250 megohms per mile, when tested with the negative pole of a 100 volts battery to the wire, after an electrification of one minute. The dielectric strength of the insulation shall be tested by immersing a sample of the insulated wire in water for seventy-two hours, and then placing it in a conducting liquid in a metal trough. All wire shall under these conditions be capable of withstanding an alternating current of 18,000 volts with a frequency of 133 per second, applied to the test sample for five minutes.

SECTION 39.

39 Weather Proof Wire

Weather-proof wire shall be made of thoroughly tinned copper wire, insulated with three separate, closely-woven braids of cotton. Each braiding, as applied, shall be completely saturated with a dense moisture-repellant compound, applied in such a manner as to drive from the cotton any moisture contained. The thickness of the finished insulation shall not be less than $^{1}/_{16}$ in., and the surface shall be hard and smooth. The covering shall retain its elasticity at a temperature of ten degrees below zero, Fahrenheit ,and shall not drip at any temperature below 180 degrees Fahr.

SECTION 40.

40 Tie Wire

Tie wires shall be of same size and material as the line wires they are to secure, and shall be made of wire that is carefully annealed, and is as soft as possible. The length of the wire shall be as follows:

Size of Line Wire.	Length of the Wire. Ins.
.080	16
.104	19
.165	22

SECTION 41.

41 Construction Specifications

For the purpose of description, it is convenient to subdivide the work of building open wire lines into the following sections:

Section 42—Location of Poles:
- A—Country Lines.
- B—City Lines.

Section 43—Distribution of Poles.
Section 44—Fitting of Poles:
- A—Gaining and Roofing.
- B—Stepping.
- C—Ringing.
- D—Protecting.
- E—Lightning Rods.

Section 45—Setting Poles:
- A—Foundations.
- B—Erection.

Section 46—Cross Arming:
- A—Straight Line Work—Single Bracing.
- B—Straight Line Work—Double Bracing.
- C—Double Arming.
- D—Alley Arms.
- E—Cable Arms.

Section 47—Setting of Pins.
Section 48—Painting.
Section 49—Guying.
Section 50—Bracing.
Section 51—Curves and Corners.
Section 52—Highway Crossings.
Section 53—Erection of Wire.
Section 54—Tension of Wire.
Section 55—Location of Wire on Pins.
Section 56—Tying of Wire.
Section 57—Wire Joints.
Section 58—Dead Ending.
Section 59—Transposition.
Section 60—Distribution.
Section 61—Protection.
Section 62—Prevention of Humming.
Section 63—House Top Line:
- A—Right of Way.
- B—Construction:
  - 1—Connection to Main Wire Plant.
  - 2—Fixtures and Circuits.

SECTION 42.

42 Location of Poles

"A"—COUNTRY LINES. Prior to the commencement of actual work, all pole locations shall be fixed by measuring off the proper distances along the route selected, to be in all cases within the limits granted in the rights of way contracts. At the points thus indicated stakes shall be set to mark the location of poles; in ordinary level country poles shall be set at uniformly equal distances of 130 ft., or in other words, there shall be forty poles per mile of line. Stakes shall be planted irrespective of obstacles, and poles set as near each stake as possible. Wherever guying or bracing is necessary, a stake shall be planted, indicating the location of the guy or brace, which shall be carefully arranged in such a manner as to completely absorb the horizontal stresses inflicted upon the poles by the circuits. On curves, at corners and other exposed locations, such a number of poles shall be placed as is necessary to secure proper strength, and the best alignment of the work. Heavy lines of seven to ten arms need more poles than light ones of two or three arms, and city lines must have more than country lines. It is rarely necessary to set poles closer together than 100 ft., and seldom expedient to build spans of more than 150 ft. These are the limits for good regular work, but as it

is impossible to specify the arrangement of poles to meet all contingencies, the design and location of the various portions within the above limits shall be left to the discretion of the foreman. If special obstacles arise, a careful sketch showing all the details (with dimensions) of the portion of the route in question, shall be submitted to the manager with request for instructions.

In lines constructed along railway rights of way, no poles shall be set at a distance of less than twelve feet from the edge of the nearest rail, unless the lowest cross arm that the line shall ever carry shall be more than twenty-two feet from the top of the rail. In such cases, with the consent of the railway company, the pole may be set to within seven feet of the edge of the rail. Along all railway rights of way all wires, cables, strands or other fixtures shall be placed so that the lowest portion of the line shall be at least twenty-two feet from the top of the rail.

Poles shall be located upon the edge of the highway in such a manner as to interfere with its use as little as possible. Whenever any portion of the line is vertically over any road or highway, all wires, strands, fixtures or cables shall be placed so that there shall in all cases be at least eighteen feet head room between the lowest portion of the line and every part of the highway.

Wherever a route shall intersect the lines or property of other telephone or telegraph company, or when two companies shall occupy the same poles, such a design shall be made as to allow the lowest wires of the line running over to clear the highest wire of the line running under by a space of at least four feet. This rule shall also apply to the clearance of all obstacles of whatsoever nature except trees.

"B"—CITY LINES. The location of poles for city lines shall be made in all respects as specified in "A". In addition, care shall be taken to place poles on the corners of streets to render guying easy. Poles shall be located just at the edge of the curb line, and as far as possible the center of each pole shall be set on a dividing property line, thus interfering with each owner as little as possible. All poles shall be placed away from driveways, gates, entrances, crosswalks, and the like.

SECTION 43.

43 Distribution of Poles

The heaviest and most substantial poles shall be placed at corners and curves, and the straightest and best poles shall be selected for city work, and of these the best appearing shall be placed in front of residences. As far as possible, poles shall be selected for length in such a manner as to balance the changes in contour of the country, and to keep the lines as nearly level as may be. Thus, short poles shall be used upon high ground, and tall poles in the valleys. It is essential to always so proportion poles that the circuits shall not pull upwards, tending to lift the insulators from their pins.

SECTION 44.

44 Fitting of Poles

A—Gaining and Roofing.
B—Stepping.
C—Ringing.
D—Protection.
E—Lightning Rods.

"A"—GAINING AND ROOFING. All poles shall be roofed, gained and bored for cross arms as specified in Section 10. The required number of gains shall be specified for each pole separately. If poles are not treated, the roof and each gain shall be painted with two thick coats of Prince's metallic paint, mixed in the proportion of 7 lb. dry paint to 1 gal. pure linseed oil.

"B"—STEPPING. Each cable pole, all painted poles in towns or in cities, and all poles fifty feet in height and over, shall be equipped with galvanized pole steps, as is illustrated in Section 23. These pole steps shall be driven on alternate sides of the pole in line with the cross arms. Poles that are less than 63 ins. in circumference shall have steps spaced 18 ins. between centers on each side; poles which exceed 63 ins. in circumference shall have the pole steps spaced 12 ins. on each side.

"C"—RINGING. Corner poles, or those in exposed locations, shall be ringed if in the judgment of the foreman this is desirable. Pole rings are specified in Section 24. Ringing shall be accomplished by shaving the top of the pole so that the ring can be driven on to the pole to 1 in. below the base of the roof. The ring shall be secured by four sixpenny galvanized wire nails driven on top of the ring spaced equally around its circumference.

"D"—PROTECTION. On all the principal streets of towns and cities, at all street corners, and in other exposed locations, where in the opinion of the foreman protection is desirable, poles shall be supplied with protection strips, or wheel guards, or both, as the foreman may deem necessary. Protection strips and wheels guards are described in Sections 25 and 26. Protection strips shall be applied to the base of the pole and secured thereto as shown in Fig. 33, with twelvepenny galvanized wire nails. Wheel guards shall be applied as shown in Fig. 33, but shall be secured with sixpenny galvanized wire nails.

"E"—LIGHTNING RODS. Every tenth pole of country lines only shall be equipped with a lightning rod. This lightning rod shall consist of a piece of No. 6 galvanized iron wire, which shall extend not less than 12 ins. above the top of the roof of the pole, and shall be attached to the sides thereof by means of galvanized steel staples (Section 32), spaced 1 ft. apart. Each lightning rod shall extend the entire length of the pole, and shall be soldered to a ground rod, driven into the earth below the surface at the base of the pole. The lightning rod shall be kept as straight as possible, and in no case shall any turns or coils be introduced therein.

SECTION 45.

45 Setting of Poles

A—Foundations.
B—Erection.

"A"—FOUNDATIONS. Under ordinary circumstances, where the ground is of normal consistency, poles shall be set to the following depths:

Poles 30 ft. or less, 5½ ft. on straight lines and 6 ft. on corners and curves.

35 ft. poles, 6 ft.	40 ft. poles, 6 ft.
45 ft. poles, 6½ ft.	50 ft. poles, 7 ft.

Poles 50 ft. or over, 8 ft.

All poles on straight lines shall be set perpendicularly. Poles on curves shall incline slightly outward, enough so that the tension of the circuits shall pull them nearly perpendicular. All holes shall be dug large enough to admit the pole without stabbing or hewing, and shall be full size at the bottom, to permit the use of iron tampers. After the pole is placed in position, only one (1) shovel shall be used in filling the hole. Three (3) tampers shall be employed to pack in the filling continuously until the hole is completely filled. Soil shall then be piled up above the surface and firmly packed around the pole. In filling in holes, use the coarse soil or gravel at the top of the hole. Where the ground is sandy or marshy, additional precautions are necessary to keep the pole from settling out of line. Where the soil is fairly firm a sand-barrel may be used. The sand-barrel is a strong barrel or cask, which shall be set at the bottom of the hole, and into which the pole shall be placed, and the barrel packed with firm loam, clay, gravel or sand, the barrel serving to distribute the pressure of the pole over a greater area of soil. When soil is only slightly soft a temporary sand-barrel may be used. This is an iron cylinder, about 3 ft. in diameter, and 4 ft. or 5 ft. in length, split longitudinally and provided with hinges and clasps. The cylinder is set at the bottom of the pole hole, the pole placed inside of it, and loam or clay rammed in place until the pole is solidly supported. The cylinder is then drawn from the excavation by a fall on the pole, and can be opened and removed. With a weaker soil the best method is to surround the pole with 6 ins. or 8 ins. of concrete, made of one part of Rosendale cement mixed with two of sand, and five of broken stone. In such cases, place a layer of concrete, 8 ins. thick, on the bottom of the hole. The concrete pole foundation is shown in Fig. 34. As the object of the concrete is to give a larger bearing surface against the soft soil, as much concrete may, within reasonable limits, be used as is necessary. Where concrete is not available, or the soil seems so soft to require an excessive amount, a foundation may be secured by bolting the transverse logs to the pole butt, as shown in Fig. 35. Such logs shall be from 4 ft. to 6 ft. long, not less than 6 ins. in diameter at the smallest end, and secured to the pole by one ⅝ in. bolt. When the soil is a veritable bog or marsh, poles shall be set on a platform, Fig. 36, or a platform and piles, Fig. 37. These methods are so obvious from the illustrations that further specification is unnecessary. The construction of Fig. 36 shall be used for 30 ft. pole, and that of Fig. 37 for larger and heavier lines, or when the ground is very soft. If hard pan or rock shall be encountered, the only precaution to be observed is to make holes large enough to receive the butt without hewing, and to excavate the hole so that the pole can stand perpendicularly. If it shall be necessary to blast pole hole, this part of the the work shall only be entrusted to those who are skilled in the use of explosives.

"B"—THE ERECTION OF POLES. Poles which are 45 ft. or less, may be erected with pike staves, as shown in Fig. 38. Care shall be taken to distribute the gang on each side of the pole, so that it may be held securely while in the air, yet so that in case of an accident no one shall be injured. To raise poles over 50 ft. a tripod derrick may be employed, as shown in Fig. 39. The derrick shall be built of three 30 ft. poles. The top of the derrick spars may be equipped with a universal swivel hinge and ring, to which the fall may be hung, or a simple lashing may be used. In the butt of each pole a solid spike, not less than 1 in. in diameter and 3 ins. long, shall be placed to prevent the butt from slipping. A four part 3 in. fall is sufficient for hoisting. For heavy poles, a winch clamped to one leg of the derrick, can be employed. The pole should be slung just above its center of gravity, so that the butt will drag on the ground and slide into the hole. As soon as the butt has entered the hole, the sling can be shifted and the pole hoisted upright. Better than either of the preceding methods is the use of a derrick wagon for all pole setting. A heavy two-horse truck is equipped with a small derrick, having a capacity of two tons, and a reach of 20 ft. in all directions. The mast is hinged at its base on the truck, so that it can be laid down for transportation. Power is best supplied by a gasoline or electric motor. With such an apparatus, poles can be set as fast as the wagon can drive.

Prior to raising, a guide cross arm shall be placed on each pole, to show which way the gains set. Before the refill is rammed about each pole, it shall be turned to bring all gains to their proper positions. On straight lines gains shall be perpendicular to the line; and on curves and corners set radially.

SECTION 46.

46 Cross Arming

A—Straight Line Work.—Single Bracing.
B—Straight Line Work.—Double Bracing.
C—Double Arming.
D—Alley Arms.
E—Cable Arms.

All cross arms shall be bolted to the pole, either with one ⅝ in. machine bolt, or two ½ in. machine bolts (Section 19), as may be specified in each case.

"A"—STRAIGHT LINE WORK—SINGLE BRACING. In straight-a-way work each cross arm shall be braced with two galvanized mild steel braces of the style and dimensions shown in Section 18—A. Each brace shall be attached to its arm by one 4 in. carriage bolt (Section 20). Both braces shall be secured to the pole by one ⅝ in. fetter drive screw (Section 21). The method and dimensions for cross arming are shown in Fig. 40.

"B"—DOUBLE BRACING. Whenever the line is exposed more than under normal conditions, back cross arm braces shall be used in addition, unless double cross arms are specified. The back cross arm brace shall be of the style and dimensions as shown in Section 18—B. Each pair of back cross arm braces shall be fastened to the pole by one 5 in. fetter drive screw (Section 21). Each brace shall be attached to the cross arms by one carriage bolt, Section 20. The method and dimensions for double bracing are shown in Fig. 41.

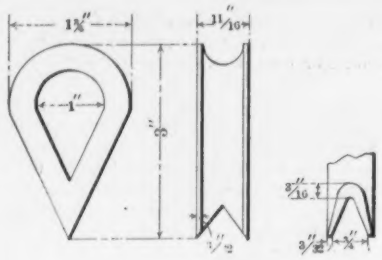


FIG. 27.—THIMBLE.

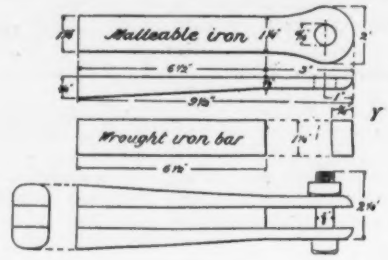


FIG. 29.—ROCK EYE BOLT.

FIG. 30.—STAPLE.

FIG. 31.—FUSE.

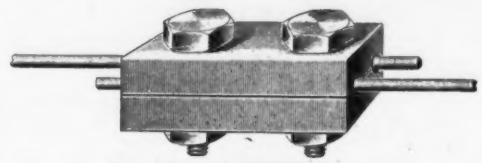


FIG. 32.—CONNNECTOR.

FIG. 33.—POLE PROTECTION.

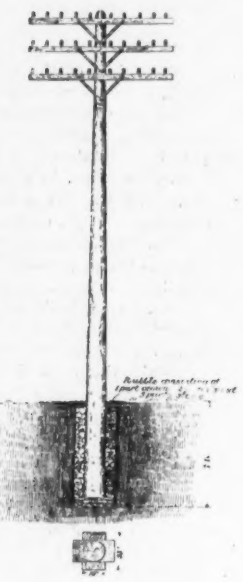


FIG. 34.—CONCRETE FOUNDATION.

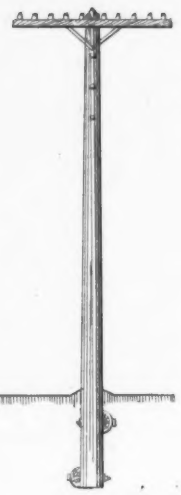


FIG. 35.—LOG FOUNDATION.

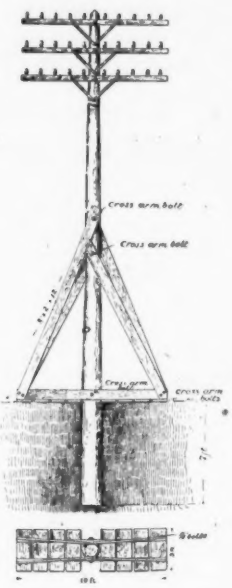


FIG. 36.—PLATFORM FOUNDATION.

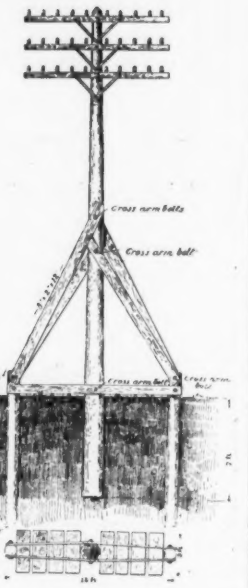


FIG. 37.—PLATFORM AND PILES.

FIG. 38.—POLE RAISING.

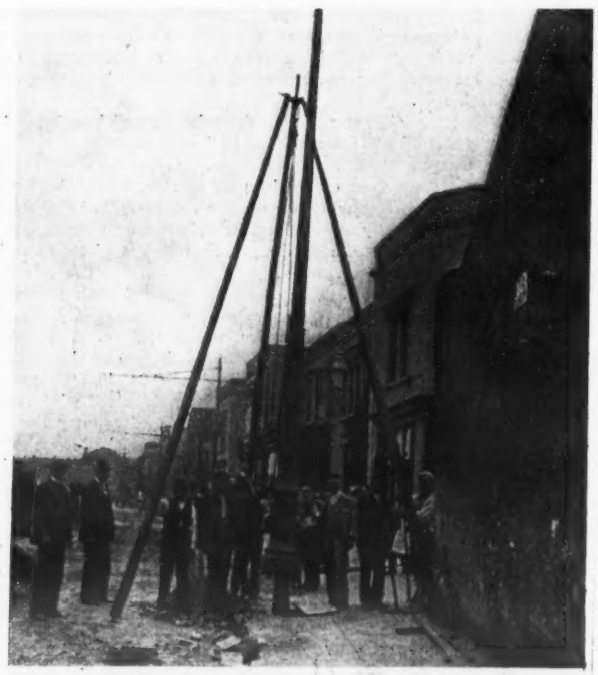
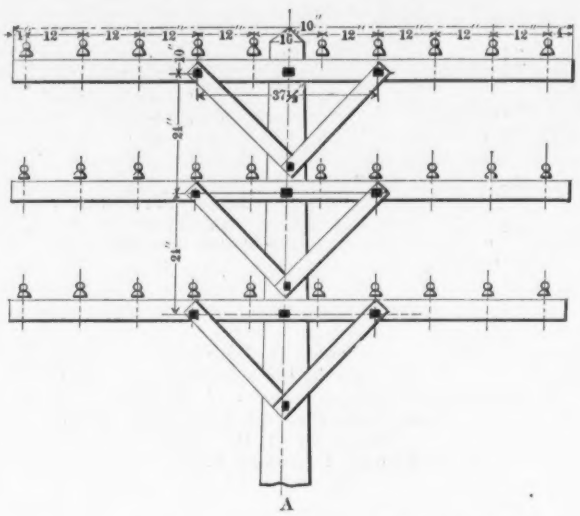
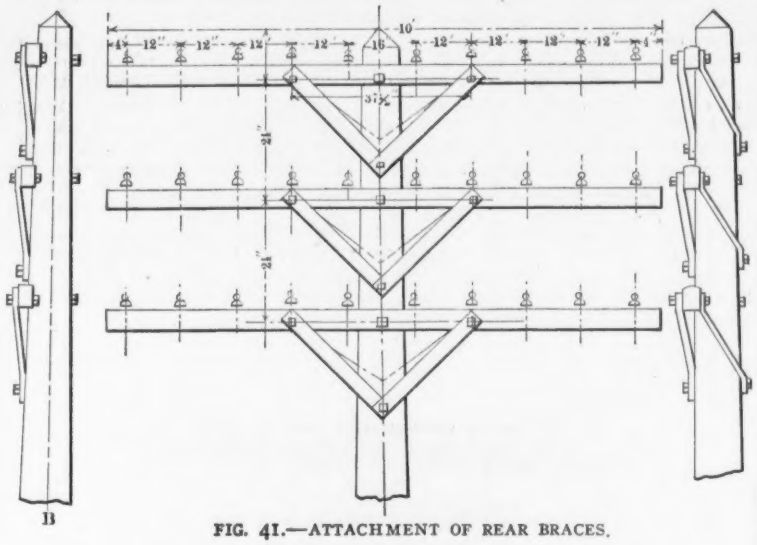


FIG. 39.—POLE DERRICK.



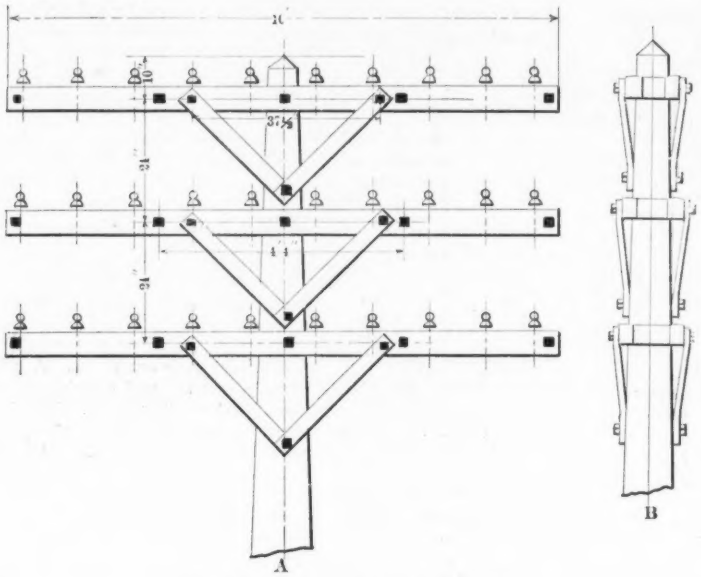
A

FIG. 40.—ATTACHMENT OF FRONT BRACES.



B

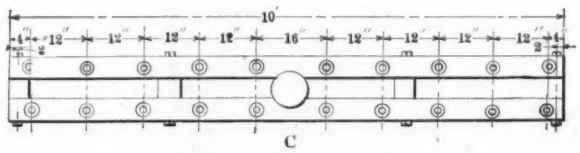
FIG. 41.—ATTACHMENT OF REAR BRACES.



A

B

FIG. 42A AND B.—DOUBLE ARMING.



C

FIG. 42C.—DOUBLE ARMING.

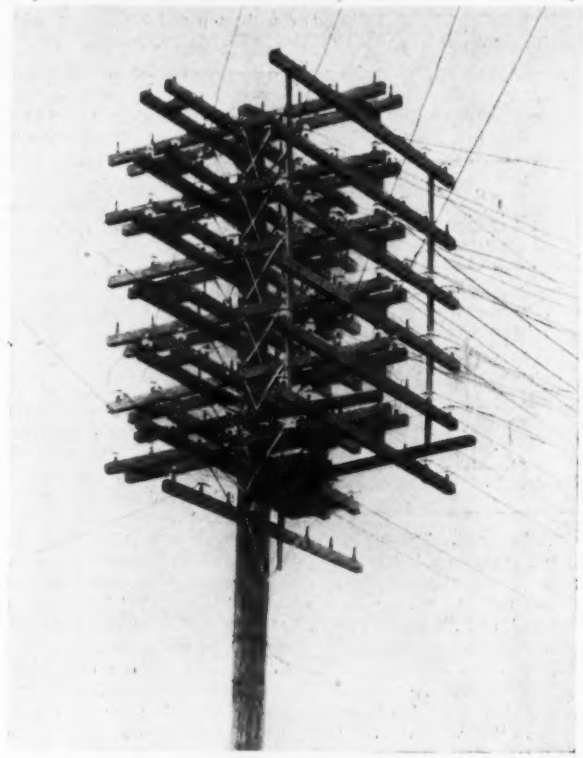


FIG. 43.—DOUBLE ARMING.

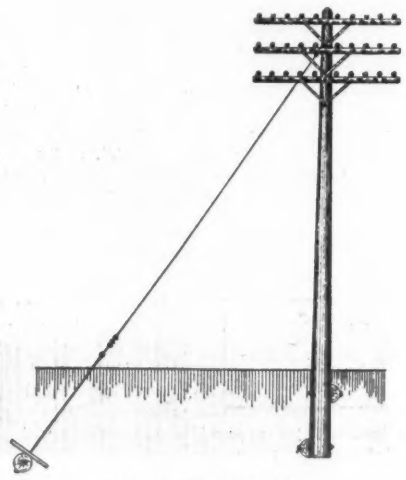


FIG. 44.—PLAIN GUY.

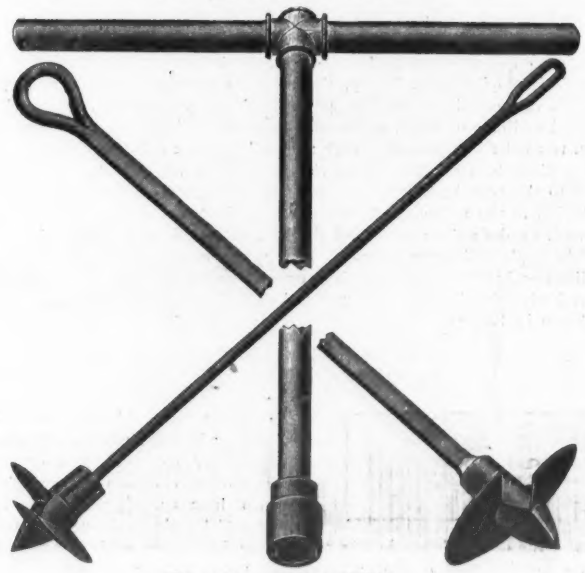


FIG. 44A.—GUY ANCHOR.

"C"—DOUBLE ARMING. Where many circuits are dead ended,—on all bad corners; in particularly exposed locations; when circuits run in several directions from a distributing pole; and at such other points as the foreman shall deem necessary,—poles shall be double armed. Double arms shall consist of two arms, one placed on each side of the pole in the manner already specified in "A", of this section. In addition, each ten pin double arm shall be secured by four blocks and double arm bolts (Section 22). The blocks shall be of pine 4 ins. x 4 ins., and of such thickness as may be necessary to fill between the arms. The double arm bolts shall be placed, and double arming done in accordance with Fig. 42—A and B. An example of double arming is given in Fig. 43.

"D"—ALLEY ARMS. Alley arms shall be erected as specified for straight line work, and in addition, the two special braces shall be attached, as shown in Section 18—C, Fig. 7. The vertical braces shall be attached to each arm with one carriage bolt (Section 20). The diagonal brace shall be attached to the pole with one fetter drive screw (Section 21), and to the arm with the same carriage bolt used for the vertical brace.

"E"—CABLE ARMS. Shall be attached to the pole and braced as specified in "A" of this Section, and according to Fig. 8.

SECTION 47.

47 The Setting of Pins

Wooden pins shall be placed at the time the cross arms are erected. Each pin shall be driven firmly into its hole in the arm, and nailed with one galvanized sixpenny wire nail, driven through the arm in the center between the top and bottom.

Iron pins shall not be erected till the line wires are strung.

SECTION 48.

48 Painting

In cities and larger towns poles shall be painted after the line is completed. Each pole shall receive two coats of first-class lead and linseed oil paint, of such a color as may be directed by the company. After painting, the butt of each pole shall receive two coats of black paint for a distance of 6½ ft. above the ground.

SECTION 49.

49 Guying

The various methods of guying are illustrated in Figs. 44 to 51, inclusive. Wherever possible, guying shall be done as shown in Fig. 44. The butt of the pole to be guyed shall be reinforced by two logs, 4 ft. to 6 ft. in length, and not less than 8 ins. in diameter at the smallest end. These logs shall be bolted to the butt of the pole, as shown. A guy rod (Section 27) shall then be planted at an appropriate distance from the pole; the greater the distance of the foot of the guy from the pole, the more valuable it is. The anchor log shall not be less than 8 ins. in diameter at the smallest end, and from 4 ft. to 6 ft. in length. Through the center of the log the guy rod shall be set and bolted. In place of the anchor log and rod, a guy anchor, as shown in Fig. 44—A, may be used, but can only be employed in loamy or clayey soils, where no rock or coarse gravel is encountered.

The guy shall be made of strand, as specified in Section 28. It shall run from a thimble in the eye of the rod to the pole, and be secured by two hitches around the pole, and a strand clamp, both at the pole and at the thimble. Where obstacles prevent running the guy, as shown in Fig. 44, guy stubs shall be used, as shown in Figs. 49 and 50. Of the two methods indicated for guy stubs, the one in Fig. 49 is the preferable one, and should be used wherever possible. In all cases guy stubs shall be reinforced by two logs, as shown. Sometimes it is possible to use trees as anchors for guys. Wherever this can be done, under private right of way authority, the methods used in Figs. 45 and 46 shall be adopted, the one shown in Fig. 45 being the preferable one. Guys shall not be attached to limbs of trees, unless the limbs are at least 5 in. in diameter. In all cases, trees shall be protected with proper lagging, as shown. Where rock exists, guying shall be accomplished as shown in Figs. 47 and 48. Guys shall be secured to the rock by means of a rock eye-bolt (Section 31). A taper hole shall be drilled in the rock and the rock and eye-bolt set as shown in Fig. 48. From the rock eye-bolt the guy strand shall be extended to the pole. All attachments shall be made with strand clamps. As often as once in each mile in straight country lines—wherever turns, crossings or corners occur—and as often as may be considered advisable in city lines, poles shall be head-guyed and double head-guyed, as shown in Fig. 51.

SECTION 50.

50 Bracing

To counteract side strain upon poles, braces may be used wherever it appears preferable, either from economy or convenience, to use a brace instead of a guy. The various forms of braces are illustrated in Figs. 52, 53 and 54. The single brace is shown in Fig. 52, and the double brace in Fig 53. These figures are self-explanatory. In Fig. 54 the Double Pole is shown. This is an exceedingly economical and desirable form, and should be employed in all exposed locations, where right of way conditions will permit. An extension of this design, making a tripod pole, may be used at particularly bad corners, and will provide a strut that will successfully withstand any gale.

SECTION 51.

51 Curves, Corners and Crossings

Where it is necessary to make any change in direction in a line, care shall be taken to make such change as gradual as possible, or, in other words, to spread the curve over as many poles as may be. Where sharp bends are unavoidable, proper guys or braces, or both, must be provided to receive all the horizontal stresses of the circuits. Figs. 55 and 56 are examples of methods of curve and corner work. Fig. 55—A is the method of making a gradual bend, which should be adopted wherever possible. At Fig. 55—B, a right angle corner, with side guys is shown. In Fig. 56—B a similar corner is shown, but this design is much stronger than Fig. 55—B, as there are two more head guys, and a brace suitable for poles, which are double armed. Fig. 55—C is a corner without guys, suitable only for light lines where guying is impractical. Poles 3 and 4 should be double poles if possible. Fig. 56—A illustrates a design suitable for the sharpest kind of a corner. At Fig. 56—D, a corner is shown made by dead-ending on the terminal poles, and cutting the circuits into cable over the corner itself. Fig. 5 "C", shows a design for two intersecting lines. As it is impracticable to specify details for all curves, corners and crossings, foremen shall build all ordinary cases as herein specified, and shall submit to the manager, for approval, a sketch with full dimensions and all other information of all cases which are not hereunder comprised.

SECTION 52.

52 Highway Crossings

Whenever a line must change from one side of a road or street to the other, the crossing shall be made so that the circuits make as near a 45° angle with the highway as possible. Pains shall be taken to select locations where the crossing can be made as in Fig. 57 A, with side guys at each terminal pole, as shown. If it is impossible to realize the condition, the crossing shall be made as in Fig. 57 B or 57 C. If the line contains more than two cross arms the head guys shall be carried three poles from the end of each line, and the first two poles shall be double head guyed.

SECTION 53.

53 Erection of Wire

"A"—COUNTRY LINES. In open country, or in thoroughfares not densely crowded —where a number of wires are to be strung simultaneously, a cart shall be provided, on which shall be placed as many reels as there are pins upon each cross arm. A good form of reel is shown in Fig. 58, while Fig. 59 shows the reel cart in use stringing wire. A running board shall be provided, as shown in Fig 60. This is a piece of tough timber 4 ins. x 6 ins. as long as the cross arm, having holes bored as shown, spaced the same distance apart as the cross arm pins. Where there is more than one arm, a split running board shall be used. A running rope shall then be carried over the cross arms of the poles for 1,500 ft. or 2,000 ft., and the running board attached to the end thereof. A team of horses shall then be attached to the rope, and the running board, with the wire attached, hauled over the cross arms. At each pole a lineman shall be stationed, whose business it is to guide the running board and wires over the cross arms. As soon as the running board arrives at the last pole over which the running rope passes the wires shall be temporarily secured, and the process repeated until the line is completely strung. After the wires are in their places, they may be drawn up by the method shown in Fig. 61, and the sags adjusted in the center of each span to the amounts prescribed in Section 54. A better method is to adjust the final tension on each wire by means of a come-along and dynamometer, shown in Fig. 62. The dynamometer is attached to the cross arm by its fall, and the wire gripped by the come-along. By means of the fall the wire may be drawn in or paid out till the dynamometer shows the tension specified in Section 54. When the wires are finally in their places, and adjusted to the proper tension and sag, they shall be tied to the insulators, as specified in Section 56.

"B"—CITY LINES. In crowded city streets, it is rarely practical to employ the running board and erect a number of wires simultaneously, and it is usually only possible to erect a single wire at a time. The method of erection consists in stringing a running rope over the cross arms of as many poles as possible, without seriously interfering with city traffic. A reel, containing the wire, shall be mounted at the beginning of the line, to which the running rope is attached, and then the wire, by means of the rope, hauled over the cross arms and lifted into place. At each cross arm the wire shall then be adjusted in proper tension and sag, as specified in "A", and tied to its insulators. This method may also be employed in country lines where but one or two wires are to be strung, and the use of the running board is inexpedient.

SECTION 54.

54 The Sag and Tension of Wires

Before wires are tied to their insulators, they shall be adjusted for tension. The proper tension depends on the length of the span, the temperature of the wire at the time of erection, and the size of the wire. There are two methods of adjusting wire; one is by means of a dynamometer, as specified in Section 53; the other is by adjusting the deflection of the wire in the center of each span below a horizontal line. In cold weather the wire contracts and the tension increases. All wire shall be so adjusted that in the coldest weather the tension shall not exceed one-third of the breaking strength. The relation between the deflection of any wire, the span between the poles, and the tension produced on the wire, is given by the following expression:

FIG. 45.—GUY TO TREE TRUNK.

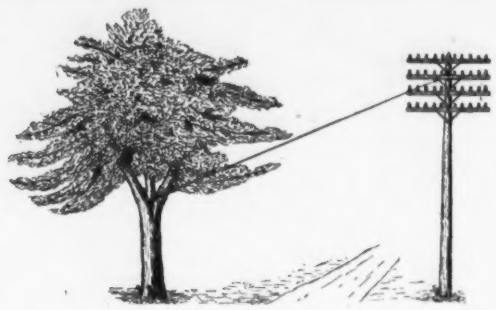


FIG. 46.—GUY TO TREE BRANCH.

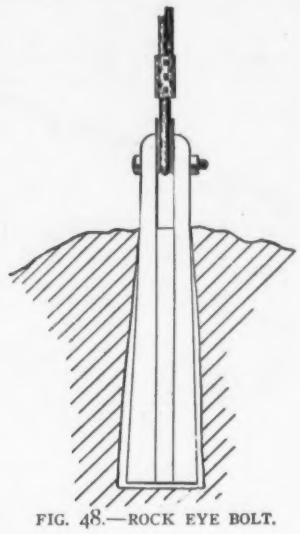


FIG. 48.—ROCK EYE BOLT.

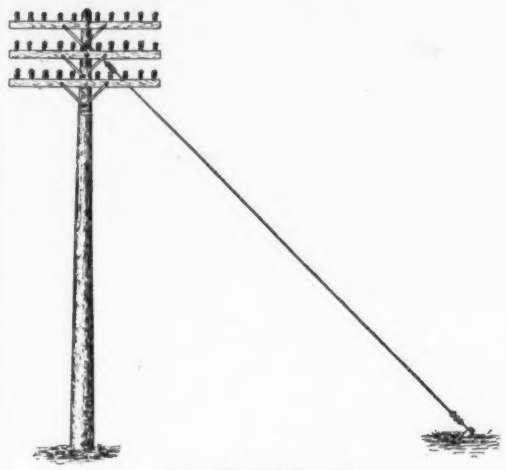


FIG. 47.—ROCK GUY.

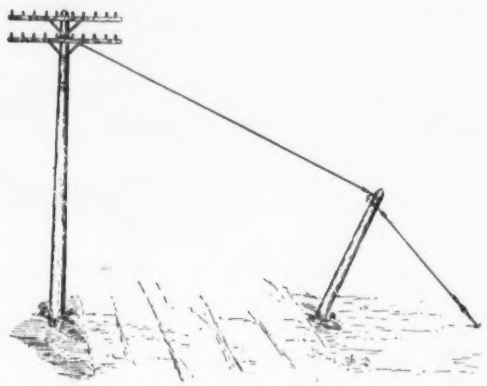


FIG. 49.—GUYS OVER OBSTACLES.

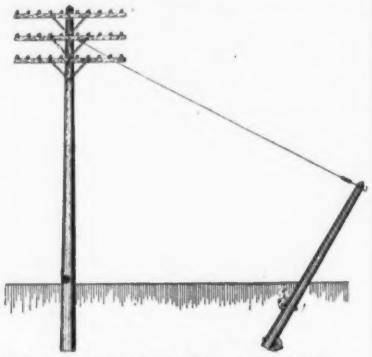


FIG. 50.—UNANCHORED GUY STUB.

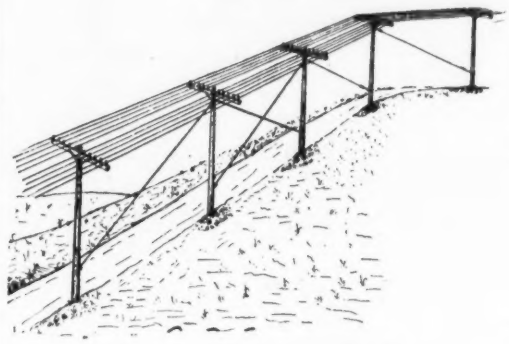


FIG. 51.—HEAD GUYING TO LINE.

FIG. 52.—SINGLE BRACE.

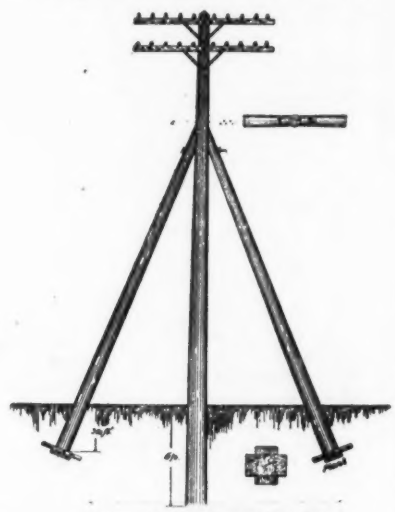


FIG. 53.—DOUBLE BRACE.

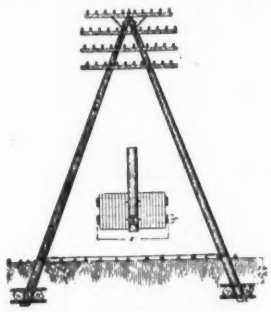


FIG. 54.—DOUBLE POLE.

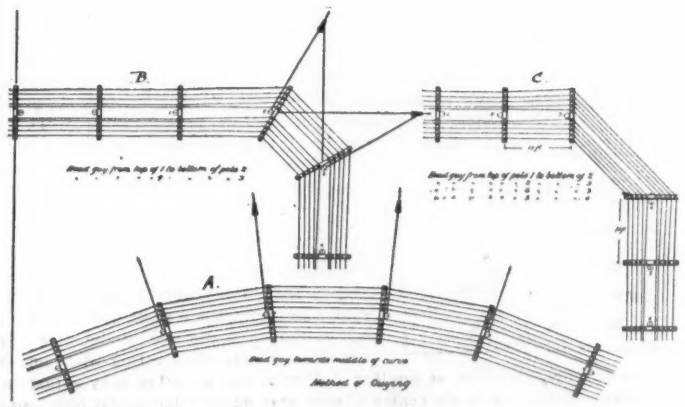


FIG. 55 CURVES AND CORNERS.

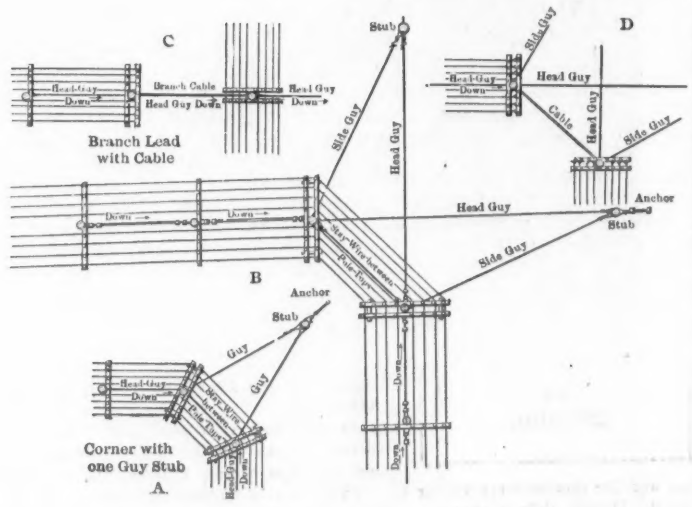


FIG. 56.—CURVE AND CORNER DETAILS.

FIG. 57A—CURVES AND CORNERS.

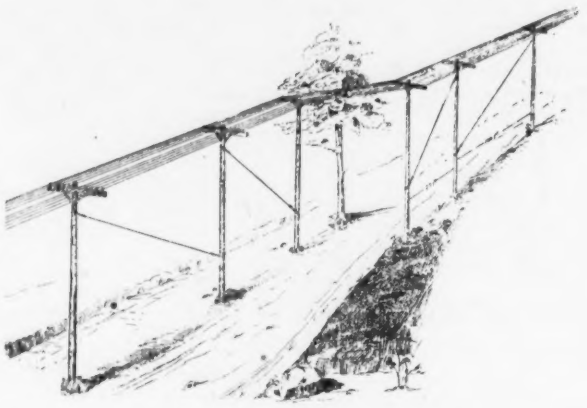


FIG. 57B—CORNERS AND CROSSINGS.

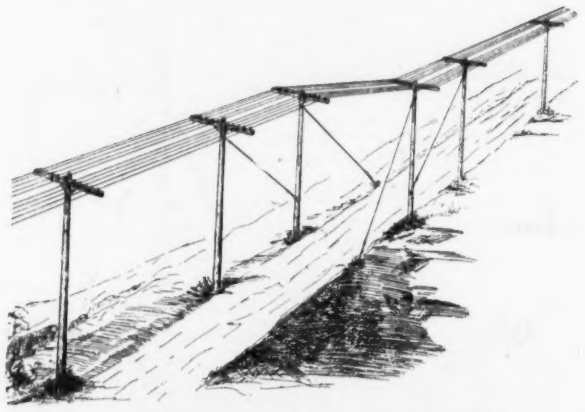


FIG. 57C—HIGHWAY CROSSING WITH SIDE GUYS.

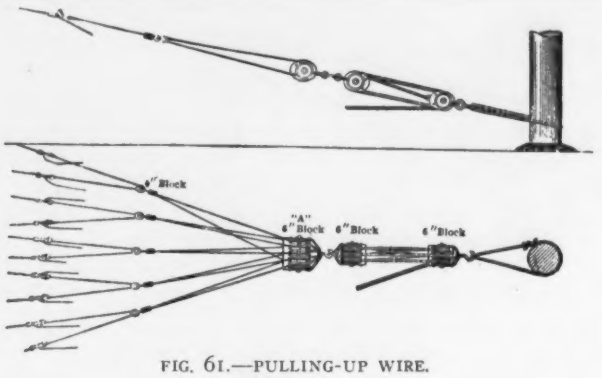


FIG. 61.—PULLING-UP WIRE.

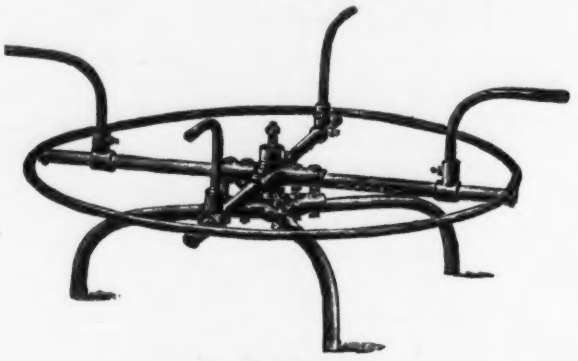


FIG. 58.—WIRE REEL.

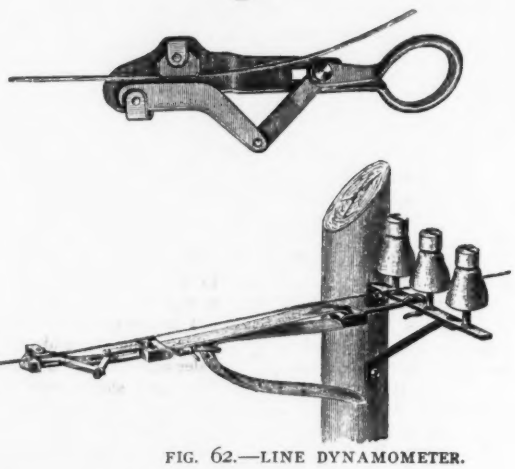


FIG. 62.—LINE DYNAMOMETER.

FIG. 60.—RUNNING BOARD.

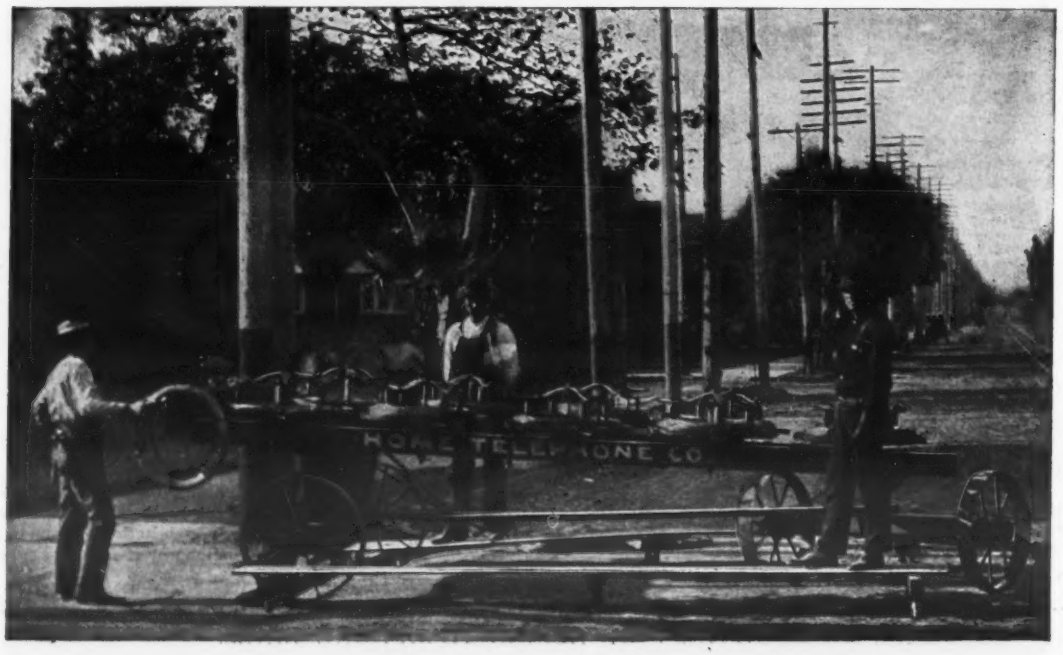


FIG. 59.—REEL CART AT WORK.

$$\text{The tension} = \frac{\text{Span}^2 \times \text{weight per foot}}{8 \times \text{the deflection.}}$$

In this formula the span and deflection are measured in feet, and the weight of the wire in pounds per foot. In Fig. 63 a table is prepared from this formula, giving all requisite information regarding sags and tensions.

First.—If wire is erected by dynamometer the proper tension is found by referring to curves "A", "B" and "C". Curve "A" is for .080 copper wire, curve "B" .104 copper, and curve "C" .165 copper. Curves "B" and "C" may be used for iron wire of similar or nearly similar sizes. Find on the lower scale the temperature at which the wire is being strung, follow a vertical line up to the curve of the proper size of wire, then a horizontal to the left-hand scale, finding the tension to which the wire shall be strung. *Example.*—A No. 12 wire is to be strung at 60° Fahr., what is the tension? From 60 follow a vertical to curve "B", thence a horizontal to the left, finding 124 pounds, and with the dynamometer the wire should be pulled to 124 pounds, no matter what the span between the poles may be.

Second.—If wire is strung by center deflection, turn the table over to the corner marked "D", find on the lower scale the span between the poles, follow a vertical line to the curve marked with the temperature at which the wire is being strung, thence a horizontal to the left-hand scale, finding the deflection in inches at the center of the span. *Example.*—What deflection shall be given to any wire strung at 60° Fahr. between poles 100 ft. apart? From 100 ft. on the lower scale follow a vertical to the curve headed + 60° Fahr., thence a horizontal to the left-hand scale, finding 4.15 ins. the proper deflection at the center of the span.

SECTION 55.

55 Location of Wire on Pins

In all straight lines, wires shall be placed on the insulators as shown in Fig. 64—A. At all corners, curves, or whenever the line is not perfectly straight, wires shall be located as shown at "B", Fig. 64.

SECTION 56.

56 Tying Wire

Each wire shall be secured to its insulator by means of a tie wire of the same metal as the line wire. The qualities and dimensions of the tie wires are as specified in Section 40, and the method of applying the tie wire shown in Fig. 65.

SECTION 57.

57 Wire Joints

"A"—COPPER WIRE. All joints shall be made, in copper wire, with McIntire sleeves. There are two forms of the sleeve—the double form, illustrated in Fig. 66, and the single form, illustrated in Fig. 67—A. There is little choice between these forms, though the single one is less likely to split. All sleeves shall be drawn of a single piece of the best annealed copper. Sleeves shall be supplied for each different size of wire, and no sleeve shall be more than .01 in. larger than the wire to which it is to be applied. Joints shall be made by slipping the ends of the wires to be joined into their respective halves of the sleeve, so that the end of each wire shall project ¼ in. through the sleeve. This end shall then be turned over, as shown in Fig. 67—B, and by means of the special McIntire pliers, illustrated in Fig. 66, the joints shall be twisted as shown in Fig. 67—B.

"B"—IRON WIRE. All joints of iron wire shall be made with what is known as the Standard Western Union joint, as illustrated in Fig. 68,

SECTION 58.

58 Dead Ending

In every case where a wire shall be terminated on a pin the method adopted at the last insulator shall be that shown in Fig. 69. A half McIntire joint shall be slipped over the wire. The wire shall then be turned around the insulator, the end slipped into the McIntire, and the joint made up all as shown in Fig. 69.

SECTION 59.

59 Transpositions

"A"—LOCATION OF TRANSPOSITIONS. Transportations are introduced into the line at frequent intervals, in order to avoid inductive disturbances. The location of transpositions on twenty-wire lines shall be made in accordance with the diagram of Fig. 70. To locate transpositions poles, proceed as follows: Measure a distance of 1,300 ft. from the first open wire pole, and mark the pole nearest the point so located as "A". Measure a second distance of 1,300 ft. from the first 1,300 ft. pole, mark the nearest pole "B". Proceed in the same manner to measure off poles at intervals of 1,300 ft. for the entire length of line. Poles so marked are designated respectively, "A", "B", "C", etc., in the diagrams, and are the poles upon which the wires shall be transposed, as shown by Figs. 70, 71 and 72. The diagram of Fig. 71 indicates the method of making transpositions on a twelve-wire line, consisting of two six-pin cross arms. Diagram in Fig. 72 indicates another method of arranging transpositions on a four-arm forty-wire line. These diagrams may be extended to any number of six-pin or ten-pin arm lines.

"B"—TRANSPOSITION DETAILS. There are two methods in common use for making transpositions. Each method requires the use of two transposition pins and two transposition insulators for each pair of wires to be transposed.

The first and older method is illustrated in Fig. 73 at "Y" and "Z", "Y" showing a plan of the lines transposed, and "Z" a perspective view, including the cross arm. This diagram is self-explanatory. It is impractical to use this form of transposition between the two circuits nearest the pole, as the cross wires from one line to another would intersect in the middle of the pole. For the two circuits nearest the pole transposition shall be made as shown in Fig. 73 at "U" and "V". The only difference is that the line wires are bent backward around the back of the insulator to avoid the pole.

STOCK LIST FOR TRANSPOSITION SHOWN IN FIG. 73.

2 Transposition pins,
2 Transposition insulators,
2 Whole McIntire joints,
6 Half McIntire joints.

The more modern method of making transpositions are shown in Fig. 74. To make this transposition, cut the wires "A" and "C" of such a length as to enable them to be dead-ended on their insulators, slip over each wire a McIntire sleeve, and run it back about 2 ft; carry each wire to its insulator and dead-end it with a half sleeve. Cut the wires "B" and "D" about 5 ft. longer than is necessary to reach their insulators, carry each to its insulator, turn it around the insulator, and dead-end it with a half McIntire; then carry the slack over the wires "A" or "C", introduce it in the McIntire joints previously specified, and twist the same into a joint.

STOCK LIST.

2 Transposition pins,
2 Transposition insulators,
2 Whole McIntire joints,
4 Half McIntire joints.

SECTION 60.

60 Distribution

Where distributing poles are used to reach subscribers' sub-stations, the open wire lines shall be terminated on their appropriate insulators upon the pole ring. From this point the drop wires shall be swung to the sub-stations. Drop wires shall either consist of twisted pair of okonite or weather-proof wire, as specified in Sections 38 and 39.

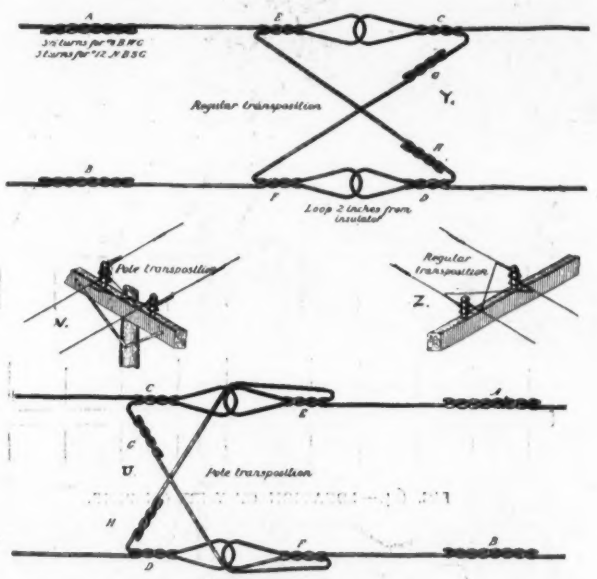


FIG. 73.—DETAILS OF TRANSPOSITION.

Where the distribution is made from open wire cross arm lines the methods shown in Fig. 75 shall be used. In all cases the wires shall be dead-ended on their appropriate insulators, as shown. A pair of knobs shall then be attached to the cross arms, directly beneath the circuits, to which the drop wires shall be attached. The drop wire may be either a pair of open wires, as at "A", or a twisted pair of okonite or weather-proof, as shown at "B". The attachment on the open wire to the open wire circuit may be made by McIntires or connectors, as at "B" or "C".

SECTION 61.

61 Protection

Whenever open wire lines run into a building or a cable, each wire shall be protected by a fuse. If the sub-station is supplied with any one of the approved forms of protection, having fuse, heat coil and spark gap, and if the cable is terminated in a similarly protected head at the open wire, no further protection shall be introduced. But in case either the cable or the sub-station is unprotected, a fuse such as is specified in Section 32, shall be introduced at the unprotected end of the line. At

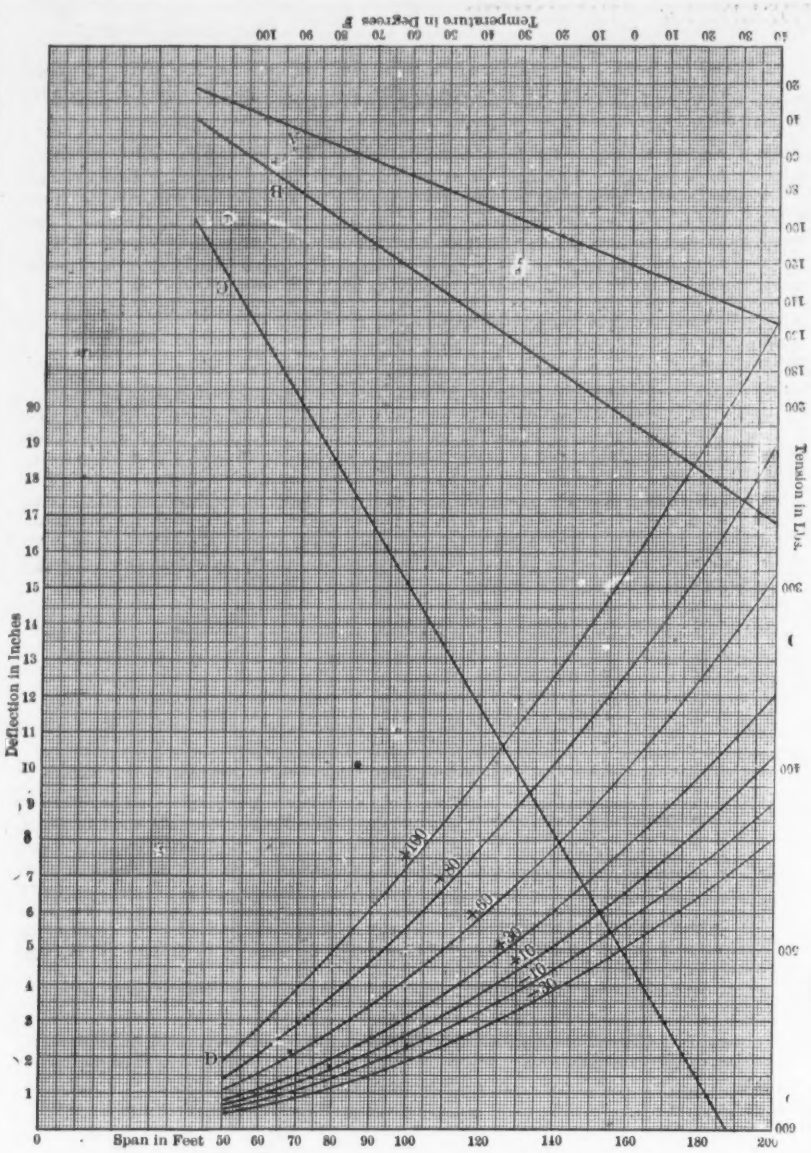


FIG. 63.—SAGS AND TENSIONS.

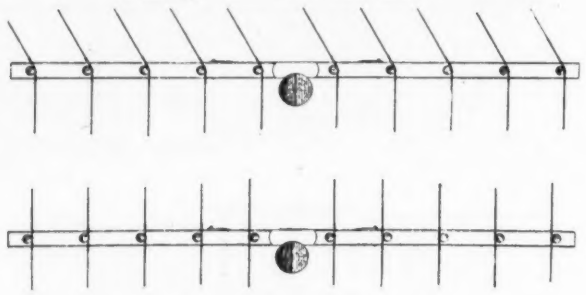


FIG. 64.—LOCATION OF WIRE ON PINS.

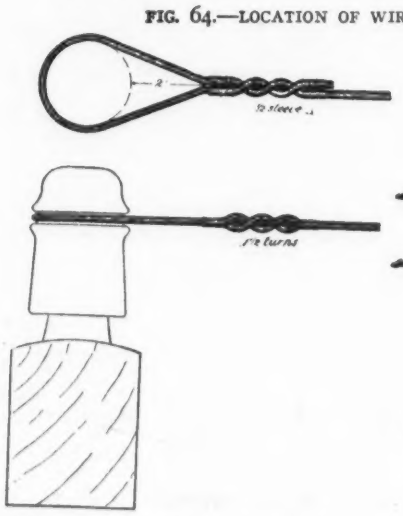


FIG. 69.—METHOD OF DEAD-ENDING.

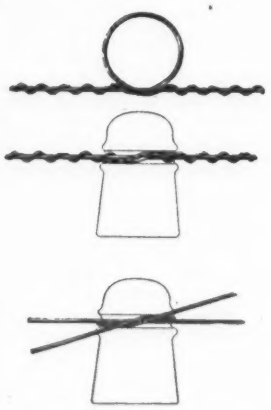


FIG. 65.—TYING OF WIRE.

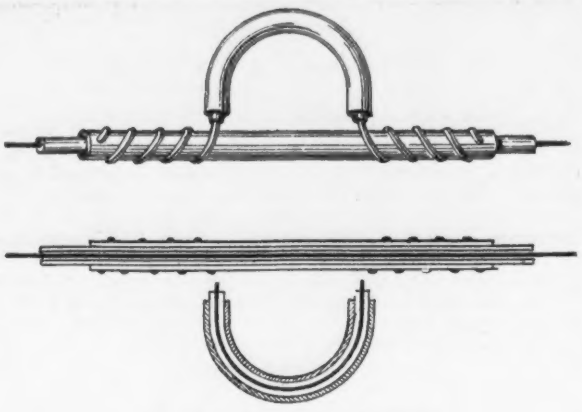


FIG. 76.—"ANTI-HUM" DEVICE.

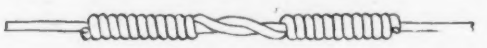


FIG. 68.—WESTERN UNION JOINT.

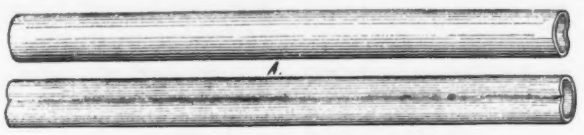


FIG. 67.—SINGLE M'INTIRE SLEEVES.

FIG. 67A.—COMPLETED JOINT.

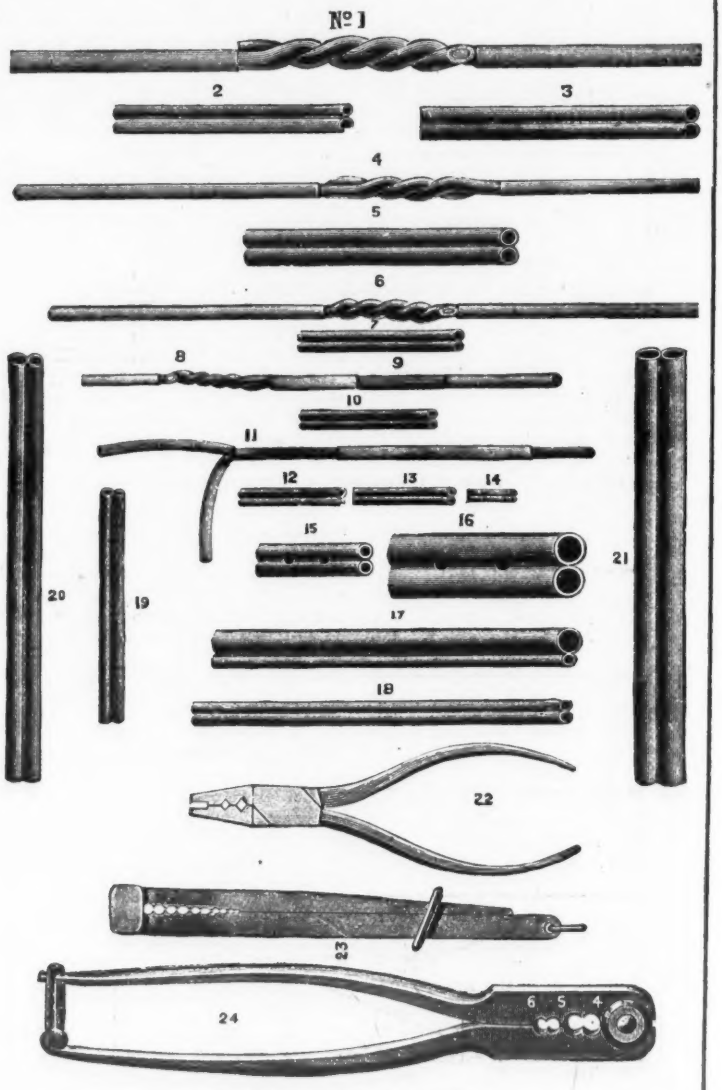
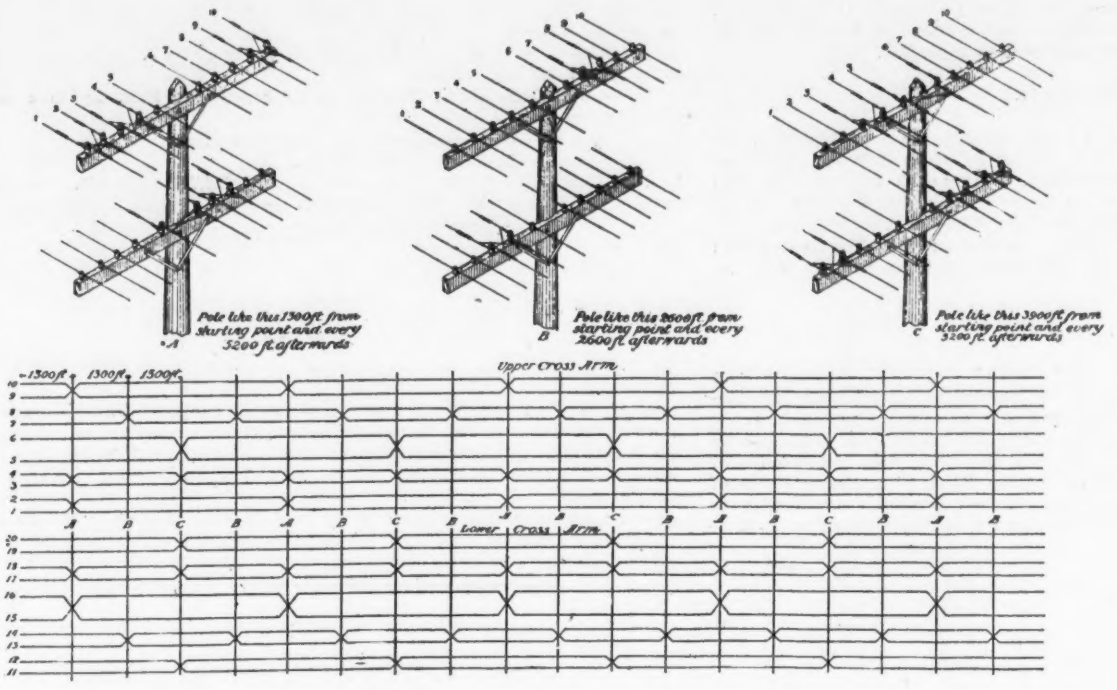


FIG. 66.—MCINTIRE JOINTS.


Pole like this 1300 ft. from starting point and every 5200 ft. afterwards
A
Pole like this 2600 ft. from starting point and every 2600 ft. afterwards
B
Pole like this 3900 ft. from starting point and every 5200 ft. afterwards
C
1300 ft.
1300 ft.
1300 ft.
Upper Cross Arm.
Lower Cross Arm.

Note—When the Pole line contains more than two Cross Arms, transpose the 3rd, 5th, 7th, etc. cross arms like the 1st, & transpose the 4th, 6th, 8th, 10th, etc. like the second cross arm.

FIG. 70.—TRANSPOSITIONS OF TWENTY-WIRE LINE.

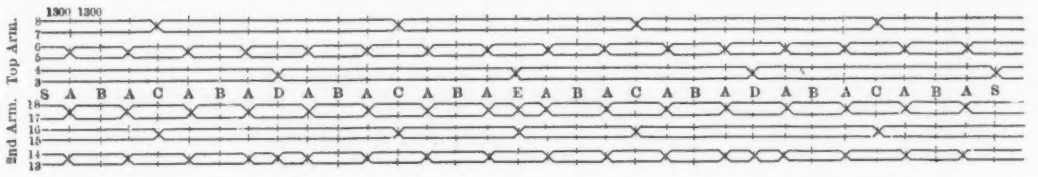


FIG. 71.—TRANSPOSITIONS FOR TWELVE-WIRE LINE.

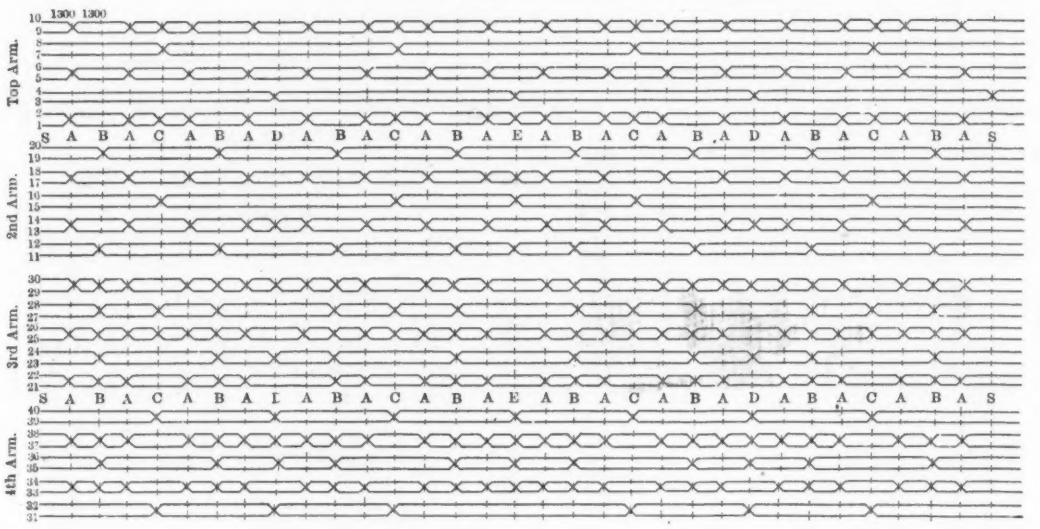


FIG. 72.—TRANSPOSITIONS FOR FORTY-WIRE LINE.

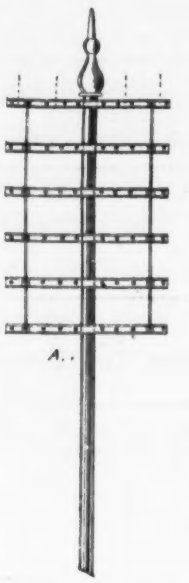


FIG. 77.—FIXTURE A.

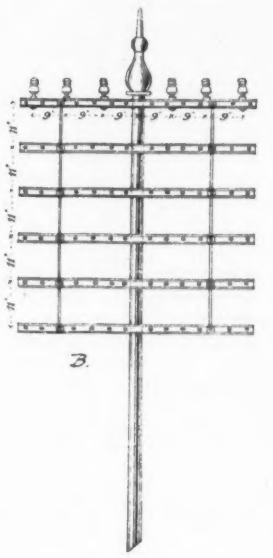


FIG. 78.—FIXTURE B.

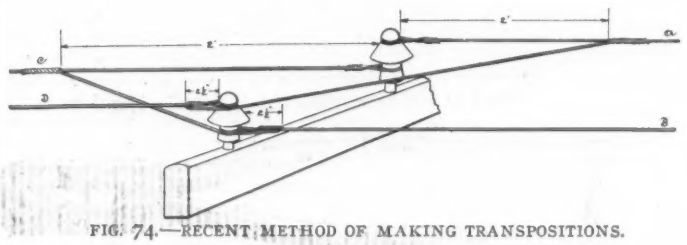


FIG. 74.—RECENT METHOD OF MAKING TRANSPOSITIONS.

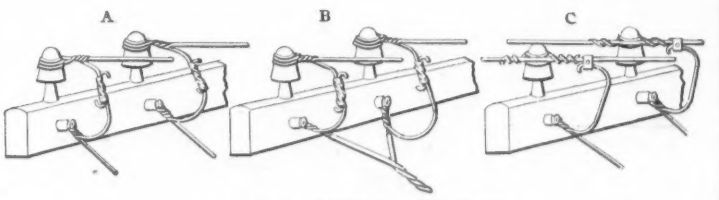


FIG. 75.—SUBSCRIBER DROP WIRES.

the cable pole the fuse shall be clamped to the open wire close to the insulator, and the bridle wire attached to the other end of the fuse. At the sub-staion the fuse shall be attached as close to the wall brackets as possible.

SECTION 62.

62 Prevention of Humming

In case of difficulty with humming, the wires causing complaint shall be tied to their insulators, as shown in Fig. 76. The line wires shall be wrapped with a piece of soft rubber about 8 ins. long, and then enclosed with a piece of sheet lead. The tie wire shall be treated in a similar manner, and then the wrapped line secured to the insulator with the wrapped tie.

SECTION 63.

63 House Top Lines

"A"—RIGHT OF WAY. House-top lines shall be confined to accomplishing distribution, and only be used for extended circuits when it is impractical to reach sub-stations by regular routes. Prior to the construction of any house-top lines, all necessary rights of way shall be obtained in writing upon the regular blank forms provided by the company. Before rights of way are negotiated a careful examination shall be made of each building to ascertain that its construction is amply sufficient to carry all the weight and stress that the contemplated line will impose. Rights of way contracts shall comprise a permission from the owner of each building to erect the necessary fixtures, guys, attachments, cables and wire; shall state the amount of compensation to be paid therefor, and the length of time for which the permission is granted. Whenever buildings are not occupied by the owners, an additional permission in writing shall be obtained from each and any tenant whose premises shall in any way be affected, either by the placing of any fixtures, wires, cables, etc., or during the process of construction. Such permissions shall be on authorized forms, and shall grant to the company leave to pass through and occupy such portions of the premises of the tenant as may be necessary for the purpose of construction and repairs, and shall state any compensation to be made therefor. Rights of way shall include and describe the methods, locations and means of extending cables or other circuits from such manholes or distributing poles in the general wire plant system of the company, as may be required to reach and serve the house-top line under consideration, and shall cover permission to occupy and use the premises of the grantor of the right of way for this purpose.

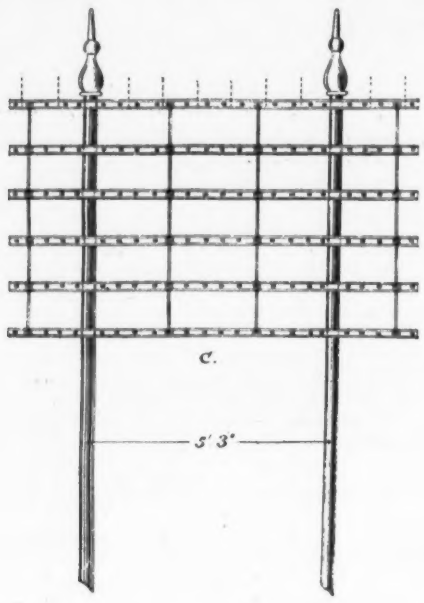


FIG. 79.—FIXTURE C.

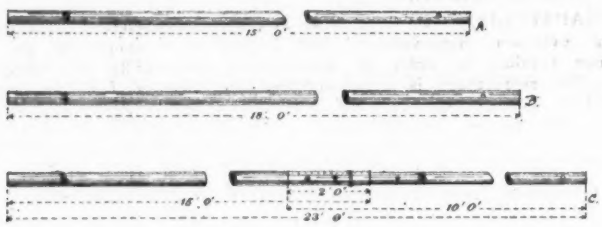


FIG. 80.—FIXTURE POLES.

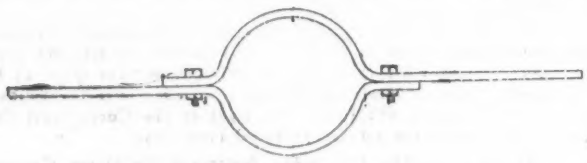


FIG. 81.—POLE STEP.

"B"—CONSTRUCTION. The actual construction of house-top lines shall consist of two parts:

1.—The Connection to the Main Wire Plant.

2.—The Fixtures and Circuits.

1.—*CONNECTION TO THE MAIN WIRE PLANT SYSTEM.* The connection to the main wire plant system shall consist in running a cable from the nearest wire plant route of the company, to the point selected for the commencement of the house-top line. For this purpose a standard cable, having a sufficient number of pairs to supply the house-top line in question, shall be run from the selected manhole or distributing pole to the roof of the building on which the house-top line shall commence. If connection is to be made with the underground a lateral shall be extended to the building, and either enter the cellar, or run upward along the outer wall to a sufficient height to protect the cable from external interference. If the lateral ends in the basement, the cable shall from its end extend to the roof through a light or elevator shaft, or such other passage-way in the building as may be found suitable for the purpose. If the cable is to run along the outside wall, it shall be placed near a leader, down spout, cornice, or moulding, so as to be as inconspicuous and protected as far as possible. In all cases the cable shall be fastened carefully and securely, as often as once in 18 ins. All fastenings shall be so made as to prevent any injury to the sheath, and to support the cable in such a manner, that the sheath shall not be unduly strained. On the roof of the building, where the house-top lines commence, the cable shall be terminated in a pot-head, or cable-head, as may be directed for each case, and by means of bridle wire each cable conductor shall be carried to its specified pin on the house-top fixtures. (See Specification for Aerial Cables.)

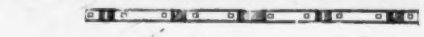


FIG. 82.—CROSS ARM FOR FIXTURE A.

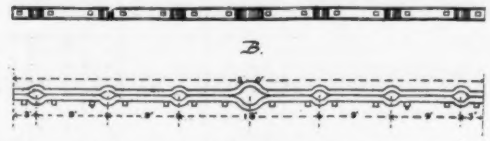


FIG. 83.—CROSS ARM FOR FIXTURE B.

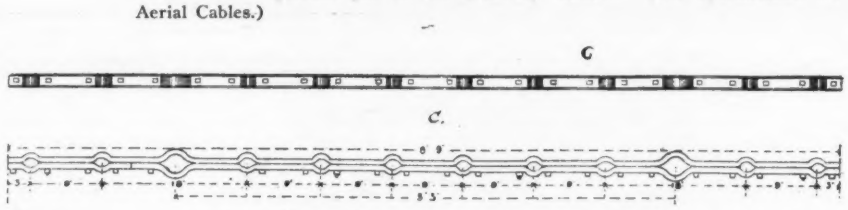


FIG. 84.—CROSS ARM FOR FIXTURE C.

2.—*FIXTURES AND CIRCUITS.* House-top lines shall be carried on house-top fixtures, which shall consist of support built of iron pipe, constructed as shown in Figs. 77, 78 and 79, specified as Fixture "A", Fixture "B" and Fixture "C". Each fixture shall consist of wrought iron pipe set in a socket placed on the building roof, and carrying one or more cross arms. There shall be three standard sizes of pipe poles, as shown in Fig. 80, at A, B and C. Pole "A" shall be made of 3 in. lap-welded tube, from 10 ft. to 15 ft. long, and shall be used for single pole fixtures "A" and "B," as shown in Figs. 77 and 78, when no more than three arms are needed. Pole "B" shall be made of 4 in. pipe, from 12 ft. to 18 ft. long, and shall be used for fixtures, "A" and "B", Figs. 77 and 78, when more than four arms are needed, and always when Fixture "C", shown in Fig. 79, is used. Pole "C" may be used for any fixture, in case conditions are such as to imperatively demand the use of a very high pole, and shall be made of one piece of 3½ in. pipe, 10 ft. long, telescoped and welded into one piece of 4 in. pipe, 15 ft. long, making a pole 23 ft. over all. Fixtures "A" and "B" should be limited to five cross arms, and Fixture "C" used when no more than 30 wires are needed. Fixture "C" can be used to carry 100 wires when built with pole "C", but it is never expedient to build house-top lines of this capacity. Poles shall be secured in their bases either by leading, or by calking into place with a rust joint, made by calking around the end of the pole a freshly-made mixture of fine iron turnings, or filings, and salammoniac in the proportion of one part of salammoniac to two parts of iron. Pole steps shall be made of ¼ in. x 3 in. flat iron bent to fit each size of pole, as shown in Fig. 81. All poles shall be made of standard lap-welded ordinary iron pipe. All pipes shall be of regular sizes and thicknesses, and shall be first-class merchantable quality in all respects.

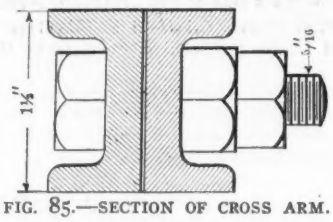


FIG. 85.—SECTION OF CROSS ARM.

CROSS ARMS. For each of the respective fixtures the cross arms shall consist of two 1½ in. channels set back to back, and fastened by 5/16 in. bolts. To secure the arms to the pole and to hold the insulator pins in position, each channel shall be bent into an approximate semi-circle of 3 ins. diameter for the pole,

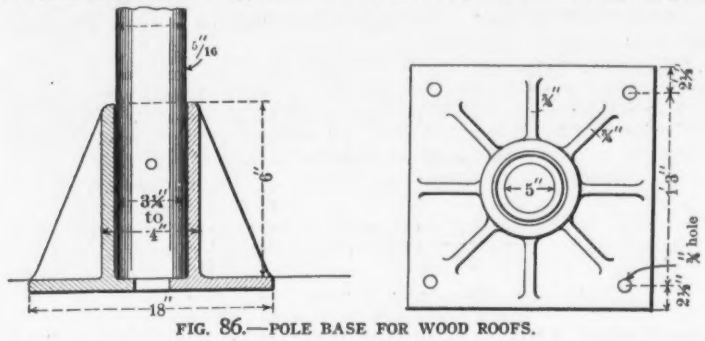


FIG. 86.—POLE BASE FOR WOOD ROOFS.

and 1 in. diameter for the pins. The channels shall be formed by heating and forging in a die. One 5/16 in. bolt shall be placed on each side of each pole, and on each side of each pin. The details and dimensions of each arm are given in Figs. 82, 83 and 84, while a cross section is shown in Fig. 85.

PINS AND INSULATORS. Shall be standard pins and insulators as specified in Sections 16 and 17.

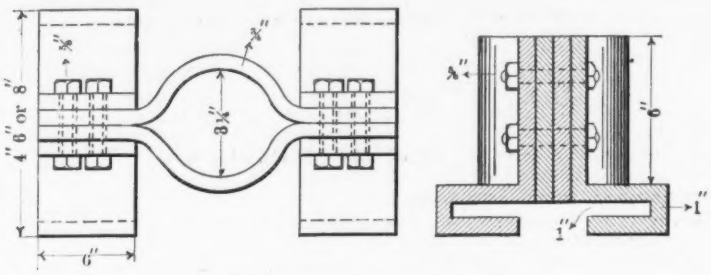


FIG. 87.—POLE BASE FOR IRON ROOF.

ATTACHMENT TO ROOF. Each pole shall be set in an iron base placed on the roof. In case of a wooden roof, the base shown in Fig. 86 shall be used, and each pole shall be set over the principal roof timbers, so that no weight shall fall on mere rafters or boarding. If necessary, a supplementary timber foundation shall be built to carry the load to the main timbers. The base shall be placed on not less than four layers of roofing felt, and secured by four ⅝ in. lag bolts. For iron roofs the base shown in Fig. 87 shall be used. This base shall be made to fit 4 in., 6 in. or 8 in. eye-beams, and shall be clamped on to the flanges of the beams of the principal roof system. By placing shims between the casting and the pole pieces, both the pole and the beam can be clamped tightly. After each fixture is in place the roof shall be made tight by flashing around the base, rubber packing or in any other manner satisfactory to the building owner.

GUYS. Each fixture shall be stayed by not less than four guys, and as many more as may be required in special cases, each made of ¼ in. steel strand. At the pole each guy shall be secured by a round turn and lashed eye, as shown in Fig. 88. Guys should be located as near the middle of the cross arms as possible. At the roof the guy shall, whenever possible, be fastened as shown in Fig. 89. A ¼ in. turn buckle or strand clamp shall be used, and the tension on all guys so adjusted to brace the pole equally in all directions. Care shall be observed to so locate the guys on each roof as to best protect the fixtures from the severest winds. If it is impossible to secure guys to the roof, they may be attached to other portions of the building. The main wall, several feet below the cornice, is the next best place, and the guys secured by driving a wall iron into the brick work. In this case the turn buckle or clamp must be placed above the roof and out of sight. Attachment to chimneys and cornices should be avoided as dangerous.

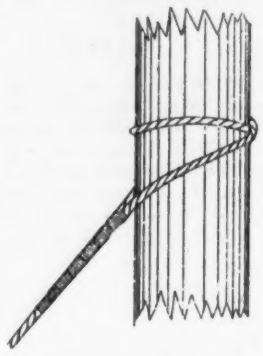


FIG. 88.—GUY AT POLE.

FIG. 89.—GUY ATTACHMENT TO ROOF.

FINISHING. After the fixture is complete, all the metal work shall receive two good coats of best metallic paint, slate color or light brown. All debris, tools or material shall be removed, the roof carefully examined and left in perfect and neat condition. In all other respects house-top lines shall be constructed of the same materials, and in the same manner as specified for regular open wire construction.

General News.

THE TELEPHONE.

SAN BERNARDINO, CAL.—The Home Telephone Company has filed articles of incorporation in the County Clerk's office here under two separate names—the San Bernardino Telephone and Telegraph Company and the Redlands Home Telegraph Company. In addition to the usual business of such companies it will establish a burglar-alarm system and a messenger service. The directorate is the same for both corporations, as follows: Arthur Wright, John Van Liew, F. F. Graves, C. L. Zahn and F. W. Wachter, all of Los Angeles. The telephone system will be built to Banning, Beaumont, Pomona, Ontario, Corona and ultimately to San Diego. The contract for installing the system is in the hands of the Cleveland Construction Company.

MAHER, COLO.—The Maher, Crawford & Hotchkiss Telephone Company, with a capital stock of $5,000, has been incorporated by G. H. Graham, W. L. Savage, A. W. Morrow and others.

WASHINGTON, D. C.—The District Commissioners have directed that the contract for furnishing underground signal and telephone cable be awarded to the Chesapeake & Potomac Telephone Company for the fiscal year beginning July 1. The company's bid was $35,636.36.

ATLANTA, GA.—C. J. Simmons has purchased a site in Atlanta which will probably be used for the erection of an exchange for the Standard Telephone Company when this corporation shall have been re-organized.

ATLANTA, GA.—Damage suits against the Southern Bell Telephone Company, aggregating $40,000 in Atlanta, have been dismissed. The suits grew out of the explosion in a manhole in the city of Atlanta.

EUREKA, ILL.—The Eureka Telephone Exchange contemplates increasing its capital stock to $5,000.

MT. OLIVE, ILL.—The Mt. Olive Telephone & Electric Company has been organized with a capital stock of $5,000. The incorporators are Gustav Schrier, W. J. Burns and G. A. Simpson.

WABASH, IND.—A complete system of rural telephones will be built in the country around Wabash this spring by the Home Telephone Company.

INDIANAPOLIS, IND.—The Patriot & North Telephone Company, of Ohio and Switzerland counties, has been incorporated with a capital stock of $5,000.

CRYSTAL, IND.—The Crystal Telephone Company has been incorporated with a capital stock of $1,000, by William A. Line, Walker Mickler and J. M. Sivilage.

FONTANET, IND.—The Merchants' Telephone Company, of Fontanet, has been incorporated with a capital stock of $5,000. The incorporators are H. J. Lambert, W. J. Randall, J. J. King and Edward King.

GREENFIELD, IND.—The Carrollton Telephone Company has increased its capital stock $3,000 and will make improvements and extend its lines. The Carrollton is a farmers' company and is giving good service.

DANVILLE, IND.—James M. Griest, of New Haven, Conn., has closed a deal with president Spencer, of the Danville Telephone Company, which gives Griest control of many telephone lines over Hendricks County. This and other deals gives Mr. Griest the local system and a dozen small exchanges and many toll lines in all directions. The price paid for the Danville company's property was $35,000. Mr. Griest had previously purchased the Plainfield system, nine miles south.

INDIANAPOLIS, IND.—The New Telephone Company, of this city, is making extensive improvements and adding new rooms to its main exchange building in order to accommodate its rapidly increasing business. The switchboard is being enlarged and changed from an old drop into a lamp signal board. New cut-off relays are also being put in. The company is also putting in a number of private branch exchanges. Similar improvements and additions are being made to the company's branch exchange on 24th Street and Talbott Avenue.

EVANSVILLE, IND.—The preliminary steps in the organization of the Municipal Telephone Company in this city were taken in a meeting held by the stockholders a few days ago, when Alexander Gilchrist, Fred Peterschein, A. F. Karges, Jas. R. Goodwin, A. P. Lahr, R. K. Dunkerson and James Gray were elected directors. In a few days the directors will decide upon what plan is best to pursue in regard to launching the municipal plant. A. J. Rouseau, representing the Stromberg-Carlson Construction Company was present, and invited the directors and city officials to go on a tour of inspection to the cities where his company has installed plants. K. McMurray, of the American Electric Telephone Company, was also present. The ordinance making the company possible provides that the amount to be raised shall be $190,000. Of this amount $135,000 has been subscribed. Any one of the numerous construction companies endeavoring to secure the contract is willing to take the remaining $55,000 worth of stock. Mayor Covert is desirous that the stock all be held by local people. Thus the Evansville telephone question is in the hands of the directors. The injunction suit to test the right of the Cumberland Company to longer occupy the streets will not be heard until June.

DES MOINES, IA.—The Ocheyedan Automatic Telephone Company has been incorporated with a capital stock of $6,000.

COUNCIL BLUFFS, IA.—C. B. McBride, president of the Honey Creek Farmers' Mutual Telephone Company has been granted the right to establish a telephone system here.

OTTUMWA, IA.—The Ottumwa Telephone Company has elected officers for the ensuing years as follows: President, Frank S. Turner; vice-president, Henry S. Herr; secretary, George S. Cowdery; treasurer, I. F. Hubbard.

LE MARS, IA.—The directors of the Le Mars Telephone Company have let a contract for the construction of their telephone system to Mark Babcock of Avoca. Stromberg-Carlson apparatus will be used. The contract calls for a system of 600 telephones.

DES MOINES, IA.—The finance committee of the Board of Directors of the Mutual Telephone Company has submitted a plan for the re-organization and financing of the company, the rebuilding of the property and readjustment of its relations to the city. The improvements contemplated will cost from $75,000 to $100,000, exclusive of the building, which will cost $50,000 more. Additional common stock will be issued instead of preferred stock and bonds, for the purpose of defraying the cost of the improvements.

KINGMAN, KAN.—The People's Telephone Company will extend its line from Leavenworth to Kansas City, Mo.

TOPEKA, KAN.—The Dewey-Wareham Telephone Company has been organized to do business in central Kansas and has been granted a charter. The capital stock is $50,000, the greater part of which is held by C. P. Dewey, of Chicago, and H. P. Wareham, of Manhattan, Kan. The company's place of business will be Junction City and Manhattan.

LUDLOW, KY.—The Ludlow Telephone Company has applied for a franchise to establish a telephone system throughout Campbell County. The company has already asked for rights in Newport, Bellevue and Dayton.

FRANKFORT, KY.—The London Telephone Company, of Laurel County, has been incorporated by the Secretary of State. The company, which has a capital stock of $10,000, will build lines to connect London with East Bernstadt, McWharter, Benge, Pittsburg and Manchester, in Clay County.

GALESBURG, MICH.—The village council has granted a franchise to the Citizens' Telephone Company.

MARQUETTE, MICH.—The Michigan Bell Telephone Company has decided to extend its long distance service to Manistique.

DULUTH, MINN.—The switchboard at the central office of the Zenith Telephone Company was burned out a few days ago as a result of the crossing of telephone wires with an arc light wire. Little damage was done to the building.

BINGHAMTON, N. Y.—It is proposed to install a police telephone system in this city.

WOLCOTT, N. Y.—The Wolcott Rural Telephone Company will construct a line from this village to South Butler, Butler Center and Red Creek.

SENECA FALLS, N. Y.—The village trustees are considering the advisability of ordering the various telephone, telegraph and other electric wires placed underground in the main business streets of this place.

BUFFALO, N. Y.—The International Railway Company is installing a telephone system for the direction of the operation of cars on its various lines. The Bell Telephone Company has secured the contract to furnish 250 telephones for this service.

ELBA, N. Y.—A. G. Small, of Rochester, who is connected with the Bell Telephone Company, is making arrangements to establish an exchange in this place. It is proposed to organize a local company to be operated in connection with the Bell system. Forty telephones will be connected with the service.

BROCKPORT, N. Y.—It is reported that the Bell Telephone Company will make application to the village trustees for a franchise to establish an exchange and system in this place. There is already a local company here with a service of 300 instruments, and there does not seem to be much sentiment in favor of the Bell Company's coming in.

CLEVELAND, OHIO.—The Standard Telephone Company has changed its location from Cleveland to Logan. Mr. W. H. Fledderjohann is president.

SPRINGFIELD, OHIO.—The Springfield & Xenia Telephone Company has been granted permission to erect an exchange building on Centre Street in this city to cost $8,000.

WEBSTER, OHIO.—The Webster Telephone Company, of Webster, Wood County, has been incorporated with a capital stock of $10,000. The names of the incorporators are Milan Jameson, J. A. Stebel, L. C. Fish, C. D. Hagerty, L. E. Philo and Anthony Seifert.

TIFFIN, OHIO.—The new Farmers' Mutual Telephone Company, of Attica,, will conduct business in Seneca, Huron and Wyandot Counties. The following-named officers have been elected: President, J. W. Walkers; secretary, Jacob Zellers; treasurer, Henry Deuchley.

WILLIAMSPORT, PA.—Farmers of the Loyalsock Valley are organizing a telephone company to build a line from Williamsport to Warrenville, a distance of 12 miles.

BROOKINGS, S. D.—The city has voted bonds to purchase the telephone system.

LE DELLE, S. D.—The South Dakota Farmers' Mutual Telephone Company, of Le Delle, has been incorporated with a capital stock of $6,000.

BEAUMONT, TEX.—The Beaumont Telephone Company has increased its capital stock from $120,000 to $200,000.

SMITHVILLE, TEX.—The Smithville Telephone Company has been organized with a capital stock of $20,000. The new company has purchased the old local system and will extend and improve the same. The officers of the new company are as follows: President, E. H. Eagleston; vice-president, W. R. Searcy; secretary and treasurer, V. S. Robb.

SALTILLO, MEX.—It is stated that John Woessner, of Saltillo, who is building a long distance telephone line between Monterey, Mex., and Torreon, a distance of 300 miles, will extend the system to a number of the other larger cities of that country.

ELECTRIC LIGHT AND POWER.

NORTH BIRMINGHAM, ALA.—The citizens have voted to issue $15,000 bonds for an electric light plant.

STOCKTON, CAL.—The City Council is making arrangements to hold a special election on a proposition to bond the city for $160,000 for the purpose of constructing a municipal electric lighting plant. Professor C. L. Cory, of the Engineering Offices, prepared plans and estimates for the use of the city authorities.

SAN FRANCISCO, CAL.—The Pacific Portland Cement Company, of San Francisco, which has its factory in Suisun, recently closed a contract with the General Electric Company for two large induction motors of 300-hp and 320 hp. respectively and a number of smaller motors aggregating 100-hp in capacity. The capacity of the plant is to be increased from 600 barrels to 1,400 barrels per day. Geo. Stone is president, N. L. Bell, vice-president, and Morris Kind, superintendent.

WEST PALM BEACH, FLA.—Joseph Jefferson, the famous actor, will be president of a new $50,000 electric light and power company to be organized at West Palm Beach.

GREEN CASTLE, IND.—A new electric light plant is contemplated for Depaw University in this city.

MUNCIE, IND.—The local electric lighting plant, belonging to C. M. Kimbrough, H. C. Hammond and others, has been sold to Muncie capitalists who will enlarge the plant and install new machinery. The purchase price is $75,000.

TAYLORVILLE, IND.—Prominent electric light men have secured options on the stock of the Citizens' Gas Company and the Taylorville Electric Company, and on April 6 the stock of the two companies was practically sold to a New York company.

MISHAWAKA, IND.—The council has sold the city water and lighting plants to the Public Utility Company for $100,000. The action was taken to avert foreclosure sales by holders of unpaid bonds. Under the deed the city reserves the privilege of buying back the plant after five years.

COLUMBIA CITY, IND.—The municipal electric light plant operated by this city in connection with a municipal water plant is proving highly satisfactory. The plant was purchased of a private company while the city was paying it $80 per lamp and it is claimed that the same are now being operated at a cost of $28 per lamp per year. The plant will be enlarged so as to accommodate the demand made upon it.

ASHBURNHAM, MASS.—The Green Electric Light, Power & Manufacturing Company, of Ashburnham, has been incorporated with a capital stock of $16,000. The names of the incorporators are Charles H. Greene, Alonzo A. Carr, Cecil F. Heyward, Edwin A. Hubbard, William O. Loveland and Henry Allison.

LESTER PRAIRIE, MINN.—W. F. Volkenant is reported interested in the construction of an electric light plant.

SOUTH STILLWATER, MINN.—Prof. J. J. Flather, of Minneapolis, is stated to have been engaged to prepare plans for an electric light plant and water works, to cost about $23,000.

STILLWATER, MINN.—The Western Gas & Electric Company is reported to have absorbed the Stillwater Gas & Electric Company and the Apple River Power Company, and will develop the power at Apple River still further for transmission to this city.

HUNTSVILLE, MO.—The Huntsville Gas & Electric Company of Huntsville, has been incorporated; capital $15,000. Incorporators: W. C. Knight and J. T. McClanahan.

MANCHESTER, N. H.—The Manchester Traction, Light & Power Co., controlled by Tucker, Anthony & Co., of Boston, has been awarded a five-year contract for lighting the city of Manchester, N. H., at $90 per light. This is a reduction of $25 per light from the previous contract.

CAMDEN, N. J.—The New Jersey Southern Gas & Electric Company recently incorporated, has taken over the properties of the Wenonah, Glassboro & Clayton Electric Company; the Electric Light, Heat & Power Company of Hammonton; The Egg Harbor Electric Lighting Company; the Swedesboro Gas Company and a water power at Weymouth, N. J.

GREENE, N. Y.—The Water Commissioners of Greene expect soon to have plans prepared for water works and an electric light plant. Address J. E. Bartoo for further information.

ATHENS, OHIO.—A proposition to issue $15,000 worth of bonds for a municipal lighting plant was carried at the recent election.

OBERLIN, OHIO.—The Council has granted L. B. Fauver and A. E. Hay, of Elyria, a franchise for a heating and electric light plant.

DEFIANCE, OHIO.—The Council has granted John F. Frost and Martin W. Steinberger, a franchise for an electric light and heating plant.

CLEVELAND, OHIO.—The Cuyahoga County Commissioners are again figuring on installing a lighting plant to supply the county buildings with light. Light costs the county over $10,000 per year and it is thought that a suitable plant could be erected for about that much money.

SOUTH BETHLEHEM, PA.—The Consumers' Heat & Power Company, of South Bethlehem, has been incorporated with a capital of $5,000.

NORRISTOWN, PA.—The town council has granted permission to the Montgomery Subway Company to lay conduits in the streets of Norristown. These conduits will accommodate electric light, telephone and telegraph wires.

READING, PA.—It is reported that the Schuylkill Navigation Company will construct an electric plant at Kissingers Dam. It will furnish lighting for the Reading shops, the shifting and freight yards, stations, etc., and for the various plants of the Reading Iron Company. The plant will use the power of the Schuylkill by means of a large turbine wheel.

CUSTER, S. D.—R. M. Fuller and Fred Beardshear, it is reported, have secured a franchise for an electric light, power and heating plant, telephone and telegraph system.

TRENTON, TENN.—The Senate has passed the bill authorizing the city to issue $15,000 electric light bonds.

COLUMBIA, TENN.—The Board of Aldermen has granted to John H. Carpenter a franchise for an electric light plant.

SPRINGFIELD, TENN.—The House has passed the bill authorizing the city to issue $35,000 bonds for an electric light plant and water works.

MEMPHIS, TENN.—The Memphis Consolidated Gas & Electric Company will expend about $93,000 in extending its conduit system in Memphis.

SPOKANE, WASH.—The City Council has granted the Spokane Light & Power Company a franchise.

CHESTER, W. VA.—The village is considering establishing a municipal lighting plant.

GRANTSBURG, WIS.—The citizens have voted for water works and an electric light plant.

SAUK CITY, WIS.—Preliminary steps are being taken to ascertain the cost of a municipal electric light plant at a probable cost of $8,500.

MADISON, WIS.—It was voted on April 7 to construct a municipal power, heating and lighting plant; a garbage disposal and sewage disposal plant and a pumping station.

WAUPACA, WIS.—The Waupaca Electric Light & Railway Co. has secured a contract for 27 or more 2,000-cp arc lights, every night from dusk until dawn, at $6.36 per light per month.

SHEBOYGAN FALLS, WIS.—The directors of the Sheboygan & Elkhart Lake Ry. & Electric Company have decided to equip the Elkhart Lake substation with apparatus for lighting and power.

DE PERE, WIS.—The Burns Boiler Company will install in its new factory a system of electric power. Each machine will be equipped with an independent motor and power will be supplied by a General Electric generator driven by a 100-hp "Ideal" engine.

TEHUACAN, MEX.—Inocente Sanchez and Ramon de la Fuente, of this city, will install an electric light plant here.

THE ELECTRIC RAILWAY.

HUNTINGTON, ARK.—The Huntington, Sugar Loaf & Rapid Transit Company has been organized with a capital stock of $100,000 to build an electric railway to connect Huntington, Prairie Creek, Montreal, Burmah and other mining towns. The officers are Bennett Brown, president; Dr. J. W. McConnell, vice-president; O. M. Harwell, secretary and treasurer.

SAN FRANCISCO, CAL.—The Board of Public Works has appointed J. C. Stut to make the estimates as to the cost of changing the present Geary Park & Ocean Railroad into an electric line.

SANTA BARBARA, CAL.—It is reported that the Santa Barbara Electric Railway, together with its power plant, has been acquired by the Huntington-Hellman interests of Los Angeles, to form a terminal for electric lines from Ventura to Santa Barbara.

DENVER, COLO.—Fred C. Adams, of Denver, is interested in a project to build an electric railway to connect Colorado Springs with Denver and Pueblo.

LOCKVILLE, CONN.—The Stafford Springs Street Railway Company, is seeking authority to increase its capital stock from $700,000 to $1,500,000. The new road will form part of the Hartford-Worcester-Boston line, promoted principally by Boston interests.

BRISTOL, CONN.—The directors of the Bristol & Plainville Tramway Company have authorized the construction of the line between Bristol and Plainville.

MADISON, IND.—The Jefferson County commissioners have granted a franchise to Hubbard, Yoder & Co., of Indianapolis, for an electric railway from Madison to Hanover.

ELKHART, IND.—The Ft. Wayne, Elkhart & Chicago Traction Company has been incorporated with $10,000 capital stock by A. H. Beardsley, S. L. Beardsley, Charles Burhaus and others.

ELKHART, IND.—The St. Joseph Valley Traction Company has elected these officers: H. E. Bucklen, president; W. B. Pratt and R. Ellison, vice-presidents; C. H. Winchester, treasurer, and S. Maxon, secretary.

INDIANAPOLIS, IND.—The Madison, Greenburg & Indianapolis Railway Company has been incorporated with $50,000. The promoters are Richard Johnson, Nicholas Horuss, W. D. Wilson, L. V. Cravens and David Johnson.

WABASH, IND.—Negotiations are on for the sale of the Wabash River Traction Company to the Union Traction Company, of Indiana. The Wabash road extends from Wabash to Logansport, 34 miles. The property is owned chiefly by Charles Blakelee and the price is understood to be $850,000.

SOUTH BEND, IND.—The Indiana Western Railway, recently incorporated, will build an electric railway from South Bend to Michigan City, a distance of about 36 miles. The line will be built for high-speed interurban service. The engineering corps is now locating the line. J. McM. Smith, general manager of the Indiana Railway Company at South Bend, is interested.

TOPEKA, KAN.—Official announcement has been made of the consolidation of the Topeka City Railway and the Vinewood Park Street Railway Company. Many prominent Eastern and Western street railway men are interested in the deal, among the names of those connected with it being L. E. Myers, of Chicago; Walton H. Holmes and Conway F. Holmes, of Kansas City; Isaac T. Burr, of Boston; E. W. Wilson, Pekin, Ill. An effort is to be made to secure a blanket franchise to cover both properties, and then the reconstruction and improvement of the system will be begun.

CUMBERLAND, MD.—The Westernport & Keyser Traction Company has been incorporated. The capital is $20,000, and the incorporators are James L. Luke, of Luke, Md.; N. U. Bond, of Bond, Md.; David P. Miller, of Cumberland, Md.; Zadock T. Kalbaugh, of Piedmont, W. Va., and James C. Watson, of Keyser, W. Va.

FALMOUTH, MASS.—The Railroad Commissioners have issued an order authorizing the Cape Cod Street Railway Company to construct its proposed road in Falmouth.

SPRINGFIELD, MASS.—The Springfield Street Railway Company will make extensive improvements and additions to its power plant, the proceeds of the sale of $250,000 of the new stock just authorized by the Massachusetts Railroad Commissioners being intended for this purpose.

DUNSTABLE, MASS.—Steps are being taken to organize and to build an electric railway to connect Tyngsboro and Lunenburg. The proposed route is about eighteen miles in length. It is proposed to capitalize the company at $200,000, and the proposed name is the Pepperell & Townsend Street Railway Company.

GRAND RAPIDS, MICH.—The Grand Rapids, Grand Haven & Muskegon Electric Railway will, it is reported, build a branch this summer from Coopersville to Ravenna, a distance of 12½ miles.

SAGINAW, MICH.—D. M. Farson, 115 Devon Street, Chicago, and G. N. Pannell, secretary Trowbridge & Niver Company, Boston, are interested in the proposed electric railway from Saginaw to Flint.

ST. LOUIS, MO.—The announcement is made that the St. Louis Transit Company has in contemplation the erection of a new power house in East St. Louis.

GREAT FALLS, MONT.—The City Council has passed a resolution to submit to a vote of the people the proposition to grant a twenty-five-year franchise to John D. Ryan and others, who recently acquired a controlling interest in the Boston & Great Falls Electric Light Company, for the operation of an electric light plant and a street railway system in this city.

TRENTON, N. J.—Active preparations have been started by Wilbur F. Saddler, Jr., for the construction of an electric railway to connect Trenton and Lambertville and intermediate points.

CAMDEN, N. J.—Contracts for the construction of the extension of the Camden & Suburban Railway from Palmyra to Riverton have been awarded to the Latta & Terry Company, of Philadelphia. The company has also awarded a contract for the construction of its line on Union Avenue and Park Avenue, Pensauken, to T. S. Drake & Company, of Philadelphia.

UTICA, N. Y.—It is understood that the increase in the capital stock of the Utica & Mohawk Valley Railway Company from $3,100,000 to $6,300,000 is to furnish funds for the construction of important extensions to the company's lines.

HOOSICK FALLS, N. Y.—A charter has been granted by the Vermont Legislature for an electric railway from Bennington, Vt., to the Massachusetts State line at Williamstown, where a short extension of the Hoosac Valley Street Railway would connect the line with North Adams and Pittsfield. Terminals will be at Great Barrington, Mass., and Bennington, a distance of sixty miles, principally through the Berkshires. Among the incorporators are C. H. Cutting, H. H. Hanley, H. W. Clark and C. Q. Richmond, of North Adams, Mass.

GREENSBORO, N. C.—It is reported that the electric street railway company of Greensboro may build a twelve mile extension.

BUCYRUS, OHIO.—The Crawford County commissioners have granted a franchise to C. A. Linn and others for an electric railway from Marion to Bucyrus.

COLUMBUS, OHIO.—The Springfield, Piqua & Troy Railway Company has been incorporated with $700,000 capital stock by Asa S. Bushnell, J. L. Bushnell, Dr. H. C. Diamond, W. G. Bowman and Fred J. Green.

CLEVELAND, OHIO.—The Northern Ohio Traction & Light Company has sold the $500,000 of 4 per cent. bonds and $500,000 of common stock which was set aside at the recent reorganization for immediate sale for improvements.

CLEVELAND, OHIO.—The directors of the Muncie, Hartford & Ft. Wayne Railway Company have elected these officers: S. M. Hexter, president; A. L. Johnson, vice-president; J. C. Gilchrist, treasurer; F. M. Osborn, secretary. The board authorized the immediate extension of the line to Bluffton, Ind., a distance of 15 miles.

COLUMBUS, OHIO.—The Columbus, Delaware & Marion Railway Company has purchased the property of the Marion Street Railway Company and the Marion Electric Light & Power Company, of Marion. The price paid for the properties is said to have been $181,000. The Columbus, Delaware & Marion Railway Company will spend a large amount of money in improving both the railway and lighting systems.

PITTSBURG, PA.—The Philadelphia Company, owning the capital stock of the Sycame Street Railway Company and the Mt. Washington Street Railway, has formally consolidated those companies as the Mt. Washington Street Railway Company.

STROUDSBURG, PA.—A company has been organized to build an electric railway from Mt. Pocono to La Anna, a distance of twelve miles. The officers are J. B. Williams, president; John Houck, of La Anna, treasurer; E. D. Dunning, of South Sterling, secretary.

UNIONTOWN, PA.—The Webster, Monessen, Belleverton & Fayette City Street Railway Company has decided to extend its lines to Uniontown, and will issue $300,000 worth of bonds secured by mortgage, the Fayette Title & Trust Company being trustee.

PITTSBURG, PA.—The rapid transit committee of the Pittsburg Chamber of Commerce, in order to secure adequate transportation facilities for Pittsburg and vicinity, will, it is said, recommend that subways be constructed and leased to traction companies at a fixed rental.

NEW INDUSTRIAL COMPANIES.

THE BEN F. BARBOUR PLUMBING & ELECTRIC COMPANY has been incorporated at Birmingham, Ala., with a capital stock of $15,000. The incorporators are Ben F. Barbour, B. C. Rickman and Charles B. Barnitz.

THE WILLIAMS ELECTRIC TELEPHONE COMPANY, of Cleveland, Ohio, has been incorporated with a capital stock of $10,000. The incorporators are Philip E. Hintz, Louis B. Spanner, E. P. Kern, C. M. White and H. H. Hammond.

THE INTERMOUNTAIN ELECTRIC COMPANY has been incorporated at Salt Lake City, Utah. The capital stock is $50,000. The officers are Samuel F. Fenton, president; E. A. Tripp, vice-president; G. C. Fenton, secretary; Louis H. Farnsworth, treasurer.

THE MOUNT OLIVE TELEPHONE AND ELECTRIC COMPANY, of Mount Olive, Ill., has been incorporated with a capital of $5,000, to manufacture and deal in electrical and other machinery, supplies, etc. Incorporators: Gustav Schreier, William J. Bruns, George A. Simpson.

LEGAL.

THEFT OF CURRENT.—George Block, a prominent merchant of Union Hill, N. J., was sentenced last week by Judge Blair in the General Sessions Court at Jersey City to sixty days' imprisonment in the county jail and to pay a fine of $250. He was convicted of defrauding the North Hudson Electric Light and Power Company by falsifying the meter supplying the electricity with which his store is lighted. His defense was a general denial. Block expected to be punished by fine only. He was greatly surprised when sentenced to imprisonment also. He was at once removed to the county jail to enter upon his term.

CONTACT WITH LIVE WIRE.—The Supreme Court of Pennsylvania, in deciding the case of Elliott vs. Allegheny County Light Company, held that in an action by a painter to recover for injuries received, where the evidence shows that he fell from a ladder and clutched at a live electric wire, and was shocked thereby, he is not entitled to recover from the electric light company, which left the wire uninsulated, the fall from the ladder being the proximate cause of the injury. The court said in part: "It is undisputed that the defendant was in nowise responsible for the slipping of the ladder, which was the originating cause of the plaintiff's fall. It would be speculative in the extreme to attempt to differentiate between the extent of the injury which he would probably have received if he had not come in contact with the electric light wire in the course of his fall. It is quite possible that the wire helped to break the fall, and thus lessen the extent of the injury. But even if the presence of the wire, in the condition in which it was, made the consequences of the fall more serious, yet it did not bring about the accident, nor was it in any sense the efficient responsible cause of the injury."

OBITUARY.

DR. JOHN HOYT LILLIE, who died in Los Angeles, Cal., on April 6, was one of the early inventors of the electric motor and electric railway in this country. Fitting it was that a modern electric street railway funeral car bore him to his last resting place. He was almost 90 years of age at his passing away. Born at Montrose, Susquehanna County, Pa., April 13, 1813, he became incidentally an electrician and inventor, finally seeing one of the toys of his youth grow into a mighty industrial utility. Contemporary with the experiments of Morse in telegraphy, Dr. Lillie, then residing in Joliet, Ill., was deeply engaged in electrical experiment, the most satisfactory of which was an electrical traction motor. It was not, however, until 1850, that the Patent Office issued the papers which recorded as "No. 7287" the improvement in "electro-magnetic engines." The text of the patent states that Lillie had invented "a new and useful machine for the generation of electro-magnetic power." The claim of "newness" made was: First, the employment of induced electricity, inducing electricity in the secondary electro-magnets, to be used as motive power, in connection with the prime mover, and to neutralize the secondary currents of the principal magnets formed by the direct current from the battery. In Martin & Wetzler's pioneer work on "The Electric Motor and Its Applications," Dr. Lillie's work is duly recorded and illustrated. Note is also made there of the traveling exhibition of Messrs. Lillie and Colton of a model electric railway, shown around 1847 and later, one notable feature of which was the use of the track as part of the return circuit. The model was discovered in a scrap heap some years ago, and was exhibited in operation at the New York Electrical Exhibition of 1896.

PERSONAL.

MR. HENRY V. A. PARSELL, the electrical engineer and designer, is sailing on April 29 for England and will not return to New York before the end of August.

DR. LEE DE FOREST has been visiting Seattle, Wash., with the object of establishing wireless telegraph stations along the Pacific coast and possibly across to Asia.

MR. SAMUEL INSULL, president of the Chicago Edison Company, will, it is announced, be re-elected a director in the American Marconi Wireless Telegraph Company.

MESSRS. DODGE & DAY, the modernizing engineers of Philadelphia, are installing a new shop management system in the works of the Link-Belt Engineering Company.

MR. W. F. D. CRANE.—The many friends of Mr. Crane will regret to hear that this well known electrical engineer is quite ill with pneumonia and will express hopes for his early recovery.

HON. W. MURRAY CRANE has been added to the executive committee of the American Telephone & Telegraph Company. He has been associated with the Bell system for some time.

MR. W. S. LAYCOCK, of the well-known firm at Sheffield, England, bearing his name, and engaged in electric car fitting, equipment, etc., is a visitor to New York and has been staying at the Waldorf-Astoria.

PROF. W. E. GOLDSBOROUGH reports that the telephone companies that have their headquarters in Chicago will occupy about 20,000 square feet of space with their exhibits in the Electricity Building, at the St. Louis Exposition.

DR. WALTHER NERNST, the distinguished German chemist, made but a brief stay in this country, to the disappointment of a host of friends and admirers. After participating actively in the Electrochemical convention last week, he sailed for home on Saturday.

DR. W. M. HABIRSHAW, of the India Rubber & Gutta Percha Insulating Company, has returned home to New York from a long trip through the West Indies and the far Southern States. The end of the winter found the veteran expert in rather poor health, but his holiday has done him considerable good.

MR. HANS PAETOW, of the firm of Paetow Brothers, of Dusseldorf, Germany, was a caller at the office of ELECTRICAL WORLD AND ENGINEER this week. Mr. Paetow is in this country placing orders for mill supplies and arranging with American manufacturers of such supplies to represent them in Germany.

MR. R. M. PATRICK is manager of the new concern started at Syracuse, N. Y., called the R. M. Patrick Electric Contracting Company. It has established general offices at the Kirk Block and with a full staff is bidding on all important contracts in its vicinity for power, telephone, lighting and railway work.

DR. AD. FRANKE, associate director of the Berlin factories of the Siemens & Halske Company, of Germany, is now visiting this country and will spend about a month here. Last week he attended the electrochemical convention, and he will now visit various stations and manufacturing establishments, going as far west as Chicago at least.

DR. R. OGDEN DOREMUS, who for fifty-one years past has been professor of chemistry at the College of the City of New York, has just resigned. His interest from the first was keen in electricity, and a number of able men in the electrical and chemical fields have been his students during fifty brilliant and eventful years of instruction.

MR. H. G. STOTT, electrical engineer of power plants, etc., for the Manhattan Elevated Company, while watching some mechanical work lately was unfortunate enough to get some chips of steel in one of his eyes. A severe surgical operation was necessary to get them out. We are glad to state that Mr. Stott has been able to resume his duties, however.

MR. GEORGE H. DAY.—Mr. George H. Day has resigned the presidency of the Electric Vehicle Company, of Hartford, to become general manager of the Association of Licensed Automobile Manufacturers, a new combination of leading factories. Ex-Gov. M. G. Bulkeley, of Hartford, vice-president of the Electric Vehicle Company, succeeds Mr. Day.

MR. FRANK C. WRIGHT has recently left the electric light plant at Dover, N. J., to become the superintendent of the Edison Electric Illuminating Company, at Lebanon, Pa. The plant at Lebanon is a large and progressive one giving 24 hours' service 365 days in the year for light and power and furnishing current to the Lebanon Valley Street Railway system.

MR. JOHN H. VAN DEN WALL BAKE, of Amsterdam, Holland, accompanied by Mr. Willem C. Mulhaus, Jr., consulting engineer for the firm, has returned home this week after a long and successful trip through the country, during which arrangements were made with several leading American electrical and mechanical concerns to represent them in the Low Countries. They sailed well pleased with the reception extended to them in the United States.

MR. ISAAC MI HUTCHISON, of Mexico City, who represents the Mexican interests of the St. Louis Car Works, and other prominent U. S. manufacturing concerns, has left for Mexico after a short visit to the United States, where he came principally regarding the perfecting of financial arrangements in connection with the extensive car building plant to be built in a new Mexico city in which he is primarily interested. The shops will turn out cars both for both for steam and electric roads.

MR. E. W. BUCKLEY, works superintendent of the British engineering firm of Mather & Platt, who has been on this side for some weeks past, has left for England for the purpose of conferring with his directors regarding the placing of some important contracts for electrical equipment, machine tools, etc., for installation in an additional plant which is about to be built by the firm. Mr. Buckley expects to return to the United States in about a month with a view to closing the contracts which it is anticipated will represent an expenditure not far short of a quarter of a million dollars.

MR. F. E. DRAKE, U. S. Director of Machinery and Electricity at the Paris Exposition of 1900, and for two years past manager of the works of the Union Elektricitäts Gesellschaft, at Berlin, Germany, which he remodeled on the latest modern lines of practice, has been offered and has accepted the presidency of the Lanyon Zinc Company with headquarters in St. Louis, whither he will proceed at once. The recognition of Mr. Drake's great executive ability is shown in his appointment to manage this large metallurgic enterprise, but it is a misfortune to the electrical industry that even for a time his services should be lost to it. He will be followed in his new sphere of work by the good wishes of a host of friends in the electrical field in Europe as well as the United States.

MR. H. E. O'BRIEN, one of the electrical experts of the Lancashire & Yorkshire Railway, arrived here this week on the White Star liner *Celtic* for the purpose of studying American electric traction methods. The British railway has already adopted electricity as a means for operating part of its suburban traffic, pointers as to the handling of which were secured some time ago by Mr. John F. Aspinwall, the general manager of the Lancashire & Yorkshire system, who paid an extended visit to this side for the purpose, It is proposed to convert electrically further lines now operated by steam. Accompanying Mr. O'Brien on this visit are Messrs. J. Wharton, freight traffic manager; G. Banks, freight traffic superintendent and assistant passenger traffic manager; J. T. Tatlow, locomotive, accountant, and F. Dale, the accountant of the company. These gentlemen will make a somewhat long visit on this side. They intend to go as far west as Chicago.

MR. W. B. HALE, chief of the Chicago laboratory of the Western Electric Company has been visiting New York and making a tour through the Eastern cities with the object of inspecting the laboratories of the educational institutions in this part of the country. During the past week Mr. Hale had the pleasure of attending the sessions of the American Electrochemical Society and meeting a great many experts and engineers there engaged in lines of work of interest to him or his company.

MR. W. WHEELER.—It is stated from Chicago that President Fish, of the American Telephone & Telegraph Company has nominated two members of the Illinois bar to succeed Gen. Sabin in the telephone field, Wm. Wheeler, of Holt & Wheeler, for president of the Chicago Telephone Company, and Mr. Richardson, now general counsel of the company, to be president of the Central Union Telephone Company. This might almost be said to smack of nepotism. The bar is evidently no bar to Mr. Fish, where real ability is concerned.

MR. JAMES ROSS, president of the Mexican Light & Power Company, and also president of the Dominion Iron & Steel and Dominion Coal Companies, has been in London, England, during the present month, and has concluded arrangements for the purchase of the City of Mexico Electric Light Company, owned by the firm of Siemens & Halske, the German bankers. In his announcement to the directors of the Mexican Power Company, most of whom are directors of the Bank of Montreal and Canadian Bank of Commerce, Mr. James Ross states that the purchase was made by an exchange of stock whereby the Mexican Power Company secures a controlling interest in the electric light company. Mr. Ross will sail from England on April 23.

MR. GEORG KIRKEGAARD, the expert model maker and electrician, was tendered a testimonial banquet on April 14, the eve of his departure for Europe. The affair was arranged by Mr. Kirkegaard's Danish friends in New York and was in recognition of his services in the promotion of the interests of Danish people in the United States. Mr. Kirkegaard has been president of the leading Danish society in New York and was the leading spirit in collecting the fund to erect the statue of Thorvaldsen now standing in Central Park. The dinner was given at Terrace Garden and was attended by some two hundred of the most prominent Danes in America. A notable feature of the occasion was the presentation to Mr. Kirkegaard of a handsome watch and chain.

Trade Notes.

PAWLING & HARNISCHFEGER, of Milwaukee, Wis., report that the recent fire at their works was confined to one building, so that the delay in production would be at worst but temporary. The works are very extensive and the other buildings ample to take care of all contracts and prospective orders.

FORD, BACQN & DAVIS, electric railway engineers, etc., New York City, will remove their offices on May 1 from 140 Broadway to the Blair Building, 24 Broad Street.

LARGE OIL FILTER.—A very large Cross oil filter has just been ordered by the B. F. Goodrich Co., Akron, Ohio, to be used in connection with a Westinghouse steam turbine. The Burt Mfg. Co. makes the Cross oil filter.

"COLUMBIA" CARBONS.—The National Carbon Company, Cleveland, Ohio, in a neat folder recently issued under the title "There is Light Within," gives some facts regarding Columbia carbons for enclosed arc light service.

"FLEXDUCT."—The Osborn Flexible Conduit Company, 19 Park Row, New York City, in its two latest folders illustrates and describes some of the principal qualities and features of "Flexiduct," and much other information regarding these goods is given.

FORT WAYNE BULLETINS.—Bulletins 1039 and 1041 of the Fort Wayne Electric Works have for their respective subjects small direct-current generators, motor-starting rheostats and direct-current belted motors. Two recent "Flyers" of the same company are on fan motors and commutator truing devices.

STERLING SPECIAL LAMP.—The Sterling Electrical Mfg. Company, Warren, Ohio, has issued a booklet pointing out the merits of the Sterling special lamp. The booklet is entitled, "Sixteen All-ways," and has two meanings, one to the lamp itself and the other to the picture of a young girl shown on the cover.

HOLTZER-CABOT ELECTRIC COMPANY, of Brookline, Mass., has just added to its handy trade literature circulars, illustrated, dealing with its electric lathe motors and with its enclosed types of small direct current power motors. These are described in detail, with tables of dimensions, speeds, etc., and diagrams of base, frame, etc.

THE ELECTRIC CONTRACT COMPANY will henceforth be located in new quarters at 202-204 Centre St., New York. It has moved from its old address to a location which gives it larger and better facilities than it has possessed hitherto. The company is a well-known manufacturer of electrical novelties including the "Evening Star" flash lamp.

"THEY SAY."—Under this title the Eureka Electric Company, of Chicago, has issued an artistic booklet containing a few expressions of appreciation recently received from users of Eureka telephone equipment. The pamphlet contains 24 pages and is gotten up in a very attractive manner. The writers of the letters express great satisfaction with the apparatus.

THE TELEPHONE DEPARTMENT of the Electric Appliance Company, Chicago, has more than doubled its capacity in floor space, machinery and employees. The steady increase in the demand for the "Eaco" line of telephones and switchboards has made this necessary. The company has many new circulars describing these telephone specialties which will be sent upon request.

THE WILLARD STORAGE BATTERY COMPANY, of Cleveland, is meeting with considerable success in the introduction of a new storage battery for automobiles lately placed on the market. The company is said to be supplying batteries to nearly all the leading manufacturers of electric vehicles in the country. Unusually high efficiency and long life are claimed for the battery.

CARL G. M. MILLER & COMPANY have opened an office at 141 Pearl Street, Boston, Mass., for the purpose of dealing in electrical machinery and specialties. They will be glad to hear from manufacturers desirous of active New England representation. Their Mr. Miller was for nine years connected with the Chase-Shawmut Company and is well known in the New England states.

DATA ON INSULATING MATERIALS.—A small pamphlet containing some curves on the dielectric strength of some of the commonly-used insulating materials has been recently issued by the Dielectric Manufacturing Company, of St. Louis, Mo. Eight curves are given, showing the dielectric strength of dry air, solid mica and "dielectrol." These curves will be valuable to all electrical engineers for reference.

"AS COOL AS A CUCUMBER."—The Emerson Electric Mfg. Company, St. Louis, Mo., has discovered a new relationship between cucumbers and electric fans, and under the title of "As Cool as a Cucumber," it has recently issued a booklet giving some cool facts regarding its Emerson fans. The facts are presented in a very catchy manner and their perusal will very likely leave in the mind of the reader a strong desire to possess an Emerson fan in view of the approaching warm season.

DYNAMO FIELD REGULATORS.—The Cutler-Hammer Manufacturing Company, of Milwaukee, Wis., has just issued a price-list and descriptive bulletin covering its new C-H dynamo field regulators. These new field regulators, like all C-H apparatus, are built to wear, and embody many improvements. The bulletin sets forth their many desirable features. The company, in anticipation of a heavy demand for these instruments, has stocked 2,000 of them and is therefore in a position to make prompt shipment.

TELEPHONE MOUTH PIECES.—The Dickinson Hard Rubber Company, Springfield, Mass., is making telephone mouth-pieces that possess several properties of value in such goods. They are made of a composition that is light in weight and has great strength, and they are finished in an excellent manner. These mouthpieces have been subjected to severe tests at the factory and have proven to be exceedingly strong and tough. They may be dropped on the floor and otherwise thrown around without sustaining any damage. The company reports that it has made a hit with them and is making them in large quantities for the trade.

"MORE LIGHT."—The Columbia Incandescent Light Company, of St. Louis, Mo., recently issued a booklet, of vest pocket size, giving some interesting facts about the Columbia lamp. Reference is made to our late friend, Mr. Aladdin, of Arabia, and the ease with which he did things with his famous lamp. The lamp business now-a-days, however, as the Columbia Company points out, is not so easily carried on. The modern lamps must have intrinsic merit, and the only way to make an electric lamp produce money is to make it produce light in every direction. The Columbia Company has just completed a new factory.

AKRON GENERATORS.—The Akron Electrical Mfg. Company, of Akron, Ohio, has recently issued an excellent 16-page illustrated bulletin in regard to its engine type generators. These are built in sizes from 1-kw up to 300-kw. The same progressive concern also makes belted generators, in regard to which it issues a bulletin; and it has a line of motors that are also treated in fully descriptive literature. The generators and motors are solidly built on good lines of design, with the best material and workmanship, and special attention is paid to such parts and details as brush rings and holders, etc. The company issues a long list of purchasers, and will be glad to answer inquiries for any of its apparatus.

HYDRA BATTERY.—In a recent comparative test of dry cells to determine their "telephone life," the Hydra cell, manufactured by the Hydra Battery Company, 70 Reade Street, New York, it is reported, came out victorious with a "telephone life" of 3.55 years to its credit, the next best showing a useful life of 2.48 years, tested under the same conditions. The Hydra is a semi-dry battery and is adapted to all uses to which batteries are applied, such as the operation of automobiles, gas engines, gasoline launches, motor cycles, telephone service, etc. The Company states that its battery is meeting with a highly satisfactory reception in the trade, and its producing facilities are taxed to the utmost to supply the demand.

A 20-FOOT LIST.—Pawling & Harnischfeger, of Milwaukee, Wis., have just issued a list of users of their cranes and hoists, in the form of a strip 20 feet long and so folded as to be readily accessible for reference. The list shows that this concern has sold machines to a very large portion of the representative concerns of this country and has a very creditable showing of foreign business besides. Their cranes and hoists in service number nearly 1,000, and the firm has an excellent representation in most every line of industry needing crane and hoist service. The list is arranged alphabetically to permit of easy reference and the types of machines are classified to show the exact service to which each machine is given, the capacity of each machine being also given. The list folds up into a small package measuring 3x4 inches in size.

THE CENTRAL ELECTRIC & MANUFACTURING COMPANY recently organized at Youngstown, Ohio, will establish a plant at Struthers, Ohio, where it will manufacture motors of small capacity besides a number of electrical specialties. The company has recently purchased from Edward McGarvey, of Bellefonte, Pa., a number of valuable patents on devices which it proposes to manufacture. One of these patents covers a selective call and lockout system for party line telephones; another is a selective annunciator system which can be used with a single circuit, and another is a recording ammeter, voltmeter and wattmeter. The most important invention is a device whereby moving cars passing over a scales can be weighed automatically and the figures indicated at a distant office. The invention makes it possible to weigh moving grain in elevators and while grain is being transferred to cars or elevators. One of these devices has been installed by the Republic Iron & Steel Company, at Youngstown, and the manufacturers will push this invention.

Record of Electrical Patents.

UNITED STATES PATENTS ISSUED APRIL 14, 1903.

[Conducted by Wm. A. Rosenbaum, Patent Attorney, 140 Nassau St., N. Y.]

725,044. INSULATOR; Charles Claydon, Searcy, Tex. App. filed Sept. 19, 1902. (See page 692.)

725,061. CIGAR LIGHTER; James J. Fleming, Elk Garden, W. Va. App. filed May 27, 1902. A small pocket case contains a lamp in the body portion and a battery and spark coil in the lid. The opening of the box creates a spark which lights the lamp.

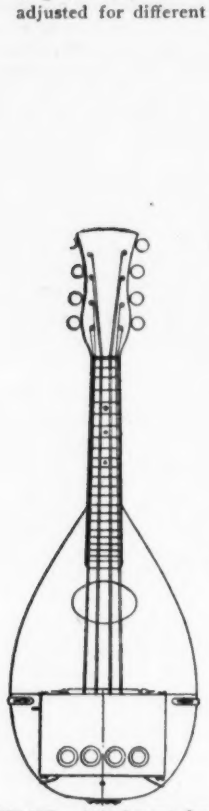
725,067. STORAGE BATTERY; William Gardiner, Chicago, Ill. App. filed Jan. 31, 1902. Details.

725,133. ELECTRIC INCANDESCENT LAMP SOCKET; Guy H. Proctor, Somerville, Mass. App. filed Feb. 3, 1902. Details.

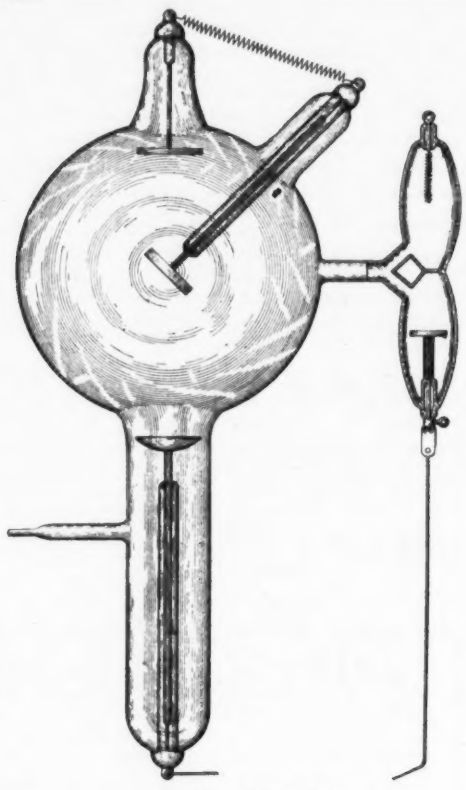
725,140. DEVICE FOR MAINTAINING CONSTANT SPEED IN ELECTRIC MOTORS; John G. Roberts, Detroit, Mich. App. filed Jan. 2, 1902. A direct current motor having a short circuit connecting opposite points of its windings and a timed circuit controller in the short circuit to keep the motor at uniform speed.

725,177. ATTACHMENT FOR MANDOLINS OR SIMILAR INSTRUMENTS; Joseph M. Timmons, New York, N. Y. App. filed Aug. 7, 1902. The strings are picked by electromagnets operated by push buttons and the fretting is done in the usual way.

725,195. CIRCUIT CLOSING DEVICE; Henry P. Ball, New York, N. Y. App. filed Jan. 29, 1902. The position of the contacts with respect to the magnet is adjustable to compensate for various positions of the core when adjusted for different loads.



725,177.—Attachment for Mandolins or Similar Instruments.



725,331.—X-Ray Tube.

725,196. RHEOSTAT; Joseph P. Ball, Frankfort, Pa. App. filed April 7, 1902. A rheostat comprising a plate of insulating material having a series of radial slots, resistance located in the slots and detachable means for holding the resistance in place.

725,208. ELECTROLYTIC COATING APPARATUS; Heinrich W. Botz, Ludwigs-hafen-on-the-Rhine, Germany. App. filed Aug. 6, 1902. Relates to the distant pieces for retaining an irregular sheet of metal in proper position in the bath.

725,214. TELEGRAPH INSTRUMENT; Carey E. Bunker, Oregon, Mo. App. filed May 23, 1901. The line circuit is open when the key is depressed instead of being closed as usual and the sounder gives out its loudest sound when released by the magnet.

725,215. TELEGRAPH KEY; Carey E. Bunker, Oregon, Mo. App. filed Aug. 31, 1901. A self-closing key having two contacts normally holding the line closed and movable on the depression of the key to successively break contact.

725,218. STORAGE BATTERY; Rufus N. Chamberlain, Depew, N. Y. App. filed Aug. 13, 1902. A cover for the cell arranged to shed moisture and direct it back into the cell, so as to prevent waste of liquid.

725,221. ELECTRIC SWITCH; Troy Cope, New Waterford, Ohio. App. filed May 6, 1902. A railway switch in which the magnets are energized by two contacts on the car engaging with two corresponding contacts in the road.

725,225. INDUCTION MOTOR; Abe L. Cushman, Concord, N. H. App. filed Oct. 13, 1902. A modification of the preceding patent.

725,239. BRUSH HOLDER FOR DYNAMOS; Eugene Gaud, Asnieres, France. App. filed Aug. 6, 1901. An arrangement by which the spring acting on the carbon works perpendicularly to the surface of the commutator.

725,244. TELEPHONE-CALL REGISTER; William Gray, Hartford, Conn. App. filed September 17, 1898. (See page 692.)

725,259. AUTOMATIC CUT OUT; Isidor Kitsee, Philadelphia, Pa. App. filed May 20, 1897. An electro-magnetic device having its coils connected in multiple and its core connected in series with the current carrying circuit, in connection with a movable member coacting with the core to close the circuit therethrough.

725,331. X-RAY TUBE; Theodor Friedlander, Chicago, Ill. App. filed June 23, 1902. As a means for varying the degree of vacuum an auxiliary anode terminal is provided capable of absorbing the gaseous atmosphere of the tube.

725,334. THERMOSTAT; Henry W. Germiner, New Boston, Ohio. App. filed Nov. 5, 1902. Details

725,355. RESISTANCE COIL; Edwin F. Northrup, Philadelphia, Pa. App. filed Feb. 4, 1903. The coils are suspended from a plate by their terminals which are reinforced for this purpose.

725,386. BELLOWS MOTOR CONTROLLER; Frank E. Whitney, Augusta, Ga. App. filed July 29, 1902. The starting rheostat is controlled by the movement of the bellows.

725,416. DEVICE FOR SHIFTING THE FIELD MAGNET FRAMES OF DYNAMO-ELECTRIC MACHINES; Wm. F. Dawson, Schenectady, N. Y. App. filed June 28, 1901. A carriage is arranged under each supporting foot of the frame, on which the frame is moved by means of suitable jack-screws.

725,436. TROLLEY WIRE CLAMP; Henry Geisenhoner, Schenectady, N. Y. App. filed July 28, 1902. A wire clamp comprising a holding member having an eye and a pair of arc-shaped clamps passing through the eye.

725,450. AIR COMPRESSOR AND HEATER; Charles R. Keller, Dayton, Ohio. App. filed Feb. 9, 1901. Compressed air is heated by an electrical heating resistance located in the tank.

725,476. TELEPHONE SYSTEM; Thomas Paul, Yorkton, Can. App. filed June 14, 1901. (See page 692.)

725,485. TROLLEY WHEEL; E. C. Rolfe, Belleville, Ill. App. filed July 8, 1902. The harp rotates on ball bearings at the upper end of the pole.

725,499. DESK FOR X-RAY APPARATUS OR THE LIKE; Horace R. Smith, Altoona, Pa. App. filed July 10, 1902. The cover of a roll top desk in which x-ray apparatus is placed, establishes the circuit when it is opened.

725,520. METHOD OF REDUCING METALLIC OXIDS WITH METALLIC ALUMINUM; Frederick C. Weber, Chicago, Ill. App. filed Aug. 6, 1902. The method of treating metallic oxids with aluminum in the production of metals and alloys which consists in subjecting the to-be-treated charge comprising aluminum in admixture with a metallic oxid reducible by aluminum, to a drying by steam heat for removal of the hygroscopic or ordinarily present moisture as a treatment preparatory to reduction.

725,523. ELECTRIC ARC LAMP; Harlan P. Wellman, Ashland, Ky. App. filed Dec. 3, 1902. Means for automatically connecting the carbon to the lamp circuit and allowing of the ready adjustment of the carbon either under the action of a clutch or when freed therefrom.

725,558. ELECTRICALLY DRIVEN CENTRIFUGAL BLAST FAN; Herman K. Grull, Vienna, Austria-Hungary. App. filed Jan. 28, 1902. A direct driven fan is adapted to utilize the entire surface of the wings for producing the draft, so that the inner diameter of the ring-shaped armature and the outer diameter of the wing are of nearly equal size.

725,592. ART OF TELEGRAPHY; Henry A. Rowland, Baltimore, Md. App. filed Nov. 23, 1897. The invention consists in transmitting over an alternating circuit by modifying the impulses for each character by cutting out the impulses in combination and so adjusting the times of current-modification that such times shall commence at the point of zero current.

725,596. ALTERNATING CURRENT MOTOR; A. W. Schramm, Philadelphia, Pa. App. filed Jan. 9, 1903. An inductance coil having a constant number of its convolutions connected with the field winding and means for connecting the brushes at will to different convolutions of the coil to thereby control the speed.

725,598. ELECTRIC CIRCUIT CLOSING MECHANISM FOR KEYED MUSICAL INSTRUMENTS; Ernest M. Skinner, Dorchester, Mass. App. filed Oct. 1, 1902. Circuit closing devices so arranged that only slight pressure on the keys will be required to close the circuit with certainty.

725,602. CIRCUIT BREAKER FOR FIRE ALARM SYSTEMS; Daniel T. Spring, Andrew Lond and Geo. H. Ebeling, Wheeling, W. Va. App. filed June 23, 1902. A box constructed so that when once pulled successive "pumpings" cannot interfere with the transmission of the signal.

725,603. REGULATOR FOR FIRE ALARM SYSTEMS; Daniel T. Spring, Andrew Long and Geo. H. Ebeling, Wheeling, W. Va. App. filed June 23, 1902. A regulator for the train in the transmitter box.

725,618. TROLLEY HEAD; Samuel Fierbaugh, Huntington, W. Va. App. filed Dec. 6, 1902. The wheel is afforded certain movement independent of the pole.

725,622. GUARD FOR THIRD RAILS; Charles W. Hornung, Jersey City, N. J. App. filed Dec. 22, 1902. A sheet metal covering shaped with a flange which fits one of the side guards to which it is fastened.